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| 10 51 13 | METAL LOCKERS | ● | ● |

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| 11 01 14 | FALL RESTRAINT EQUIPMENT [C] | ● | ● |
| 11 52 13 | PROJECTION SCREENS & PROJECTOR MOUNTS [C] | ● | ● |

**DIVISION 12 – FURNISHINGS**

| 12 24 13 | ROLLER WINDOW SHADES | ● | ● |
| 12 48 13 | FLOOR MATS AND FRAMES | ● | ● |
| 12 61 00 | FIXED SEMINAR TABLES [C] | ● | ● |
| 12 93 00 | SITE FURNISHINGS [C] | ● | ● |

**DIVISION 13 – SPECIAL CONSTRUCTION - NOT USED**
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### VOLUME 3

### DIVISION 21 – FIRE SUPPRESSION

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BIDDING DOCUMENTS AND CONTRACT FORMS

Henderson Addition – Biobehavioral Health Building

The Pennsylvania State University
University Park Campus
University Park, Centre County, Pennsylvania

DGS Project No. 800-290
PSU Project No. 06-42744

| Hazardous Building Materials Abatement | 800-290.HA1.1 |
| Building Demolition | 800-290.BD2.1 |
| General Trades | 800-290.GC3.1 |
| Fire Protection | 800-290.5 |
| Plumbing | 800-290.3 |
| HVAC | 800-290.2 |
| Electric | 800-290.EL1.4 |
| Telecommunications | 800-290.TL2.4 |
| Landscaping | 800-290.LA4.1 |

September 20, 2010

Massaro CM Services, LLC
120 Delta Drive
Pittsburgh, PA 15238

The Pennsylvania State University
University Park Campus
University Park, PA

Bohlin Cywinski Jackson
8 West Market Street
Wilkes-Barre, PA 18701
Henderson Addition – Biobehavioral Health Building

Located at:

The Pennsylvania State University
University Park Campus
University Park, Centre County, Pennsylvania

DGS Project No. 800-290
PSU Project No. 06-42744

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<td>General Trades</td>
</tr>
<tr>
<td>Fire Protection</td>
</tr>
<tr>
<td>Plumbing</td>
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<tr>
<td>HVAC</td>
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<tr>
<td>Electric</td>
</tr>
<tr>
<td>Telecommunications</td>
</tr>
<tr>
<td>Landscaping</td>
</tr>
</tbody>
</table>

Bohlin Cywinski Jackson
8 West Market Street
Wilkes-Barre, PA 18701
T- 570.825.8756
F-570.875.3744

Massaro CM Services, LLC
120 Delta Drive
Pittsburgh, PA 15238
T-412.963.2800
F-412.599.0039
SECTION A

NOTICE TO BIDDERS

1. THE PENNSYLVANIA STATE UNIVERSITY, Owner, invites bids for the following contract:

<table>
<thead>
<tr>
<th>Service</th>
<th>DGS Contract #</th>
<th>BID DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazardous Building Materials Abatement</td>
<td>800-290.HA1.1</td>
<td>10/21/2010</td>
</tr>
<tr>
<td>Building Demolition</td>
<td>800-290.BD2.1</td>
<td>10/21/2010</td>
</tr>
<tr>
<td>General Trades</td>
<td>800-290.GC3.1</td>
<td>10/21/2010</td>
</tr>
<tr>
<td>Fire Protection</td>
<td>800-290.5</td>
<td>10/19/2010</td>
</tr>
<tr>
<td>Plumbing</td>
<td>800-290.3</td>
<td>10/19/2010</td>
</tr>
<tr>
<td>HVAC</td>
<td>800-290.2</td>
<td>10/19/2010</td>
</tr>
<tr>
<td>Electric</td>
<td>800-290.EL1.4</td>
<td>10/20/2010</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>800-290.TL2.4</td>
<td>10/20/2010</td>
</tr>
<tr>
<td>Landscaping</td>
<td>800-290.LA4.1</td>
<td>10/20/2010</td>
</tr>
</tbody>
</table>

PSU PROJECT: Henderson Addition – Biobehavioral Health Building
DGS PROJECT NO.: 800-290
PSU PROJECT NO.: 06-42744
LOCATED AT: The Pennsylvania State University
University Park Campus
University Park, Centre County, Pennsylvania

2. SEALED PROPOSALS will be received by the Owner at: The Pennsylvania State University, Physical Plant Design & Construction Division, Room 106, Physical Plant Building, University Park, Pennsylvania, 16802. All bids are due by 3pm sharp on the BID DATE specified. Bids will be received from 8AM to 3PM sharp on the BID DATE specified. The Bid opening is open to the public and bids will be opened shortly after 3PM in Room 214 of the PSU Physical Plant (OPP) Building. [C]

BID DATE: Various – See above
BRIDGE BUILDING ABATEMENT COMPLETION DATE: December 24, 2010
BRIDGE BUILDING DEMOLITION COMPLETION DATE: January 13, 2011
SUBSTANTIAL COMPLETION DATE: October 19, 2012
FINAL COMPLETION DATE (completion of all punch list items): November 14, 2012

Refer to Section H2 for preliminary schedule and activity durations.
3. PREBID CONFERENCE: A Prebid Conference will be held in accordance with the following schedule: all stated times are Prevailing Time,

<table>
<thead>
<tr>
<th>Project Description</th>
<th>DGS Contract #</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazardous Building Materials Abatement</td>
<td>800-290.HA1.1</td>
<td>9/28/2010</td>
</tr>
<tr>
<td>Building Demolition</td>
<td>800-290.BD2.1</td>
<td>9/28/2010</td>
</tr>
<tr>
<td>General Trades</td>
<td>800-290.GC3.1</td>
<td>9/28/2010</td>
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<tr>
<td>Fire Protection</td>
<td>800-290.3</td>
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<td>800-290.LA4.1</td>
<td>9/28/2010</td>
</tr>
</tbody>
</table>

In the Heritage Hall of the Hetzel Union Building (HUB), University Park Campus, University Park, Pennsylvania. All prime contract bidders are required to attend the same Prebid Conference which starts at 9:00 AM. Doors open at 8:00 AM. There will be a brief walk through of the existing bridge building as well as access to the steam tunnel which runs through the project site. This walk through will commence following the Prebid Conference.

4. BIDDING DOCUMENTS. Plans and specifications are available for purchase through the Washington Reprographics Online Plan Room. Please contact Tim Jones (tjones@massarocms.com, 412-963-2800 x260) at Massaro CM Services to become a registered user. Drawings, specifications, supplemental Prebid documents and communication will be issued via email through the Online Plan Room to registered users. Bidding documents will also be available for review in room 106, Physical Plant Building, University Park, PA. There is no cost associated with becoming a user of the Online Plan Room.

Bidders shall use complete set of Bidding Documents in preparing Bids; neither the Owner nor Architect assumes responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents. All bidders are advised that they are responsible to obtain adequate bidding documents to determine all conditions affecting their work.

5. PREQUALIFICATION. All contractors bidding the prime contracts are required to complete a Massaro pre-qualification form and submit it to Massaro by October 4, 2010. The form is available in Section H7. In addition, all contractors bidding on the Abatement, Demolition and Telecommunications prime contracts or bidding on the Building Automated Systems scope of work included in the HVAC prime contract will need to be pre-qualified through BOTH Massaro and The Pennsylvania State University. The PSU pre-qualification form can be found on the Office of Physical Plant website at www.opp.psu.edu. The PSU pre-qualification process takes approximately 2 weeks.

6. BID GUARANTY. A Bid Guaranty in the form of a Certified Check or a Surety Company’s Bid Bond shall be submitted with the Proposal in an amount of not less than five percent (5%) of the total Bid amount.

In the event that any Bidders shall, upon the award of a contract, fail to comply with terms of the Proposal and/or Contract Documents, the amount of the Bid Guaranty shall be forfeited to the Owner.

7. PERFORMANCE AND PAYMENT BONDS. The Contractor, at the time of execution of the Agreement, shall furnish, at its own cost and expense, Performance and Payment Bonds covering the faithful performance of the Contract and the payment of all obligations arising therefrom, each in the full Contract amount and in such form as the Owner may prescribe.
8. THE FORM OF PROPOSAL must be delivered in a sealed envelope, all blanks fully filled in, **ALL PRICES BEING INDICATED IN WORDS**, as also in figures, and the complete form without interlineation, alteration or erasures, and executed by the proper person or persons authorized to sign for the firm, corporation, or individual Bidder.

The sealed bid envelope shall be addressed to:

The Pennsylvania State University

Physical Plant Design & Construction Division

Room 106, Physical Plant Building

University Park, Pennsylvania 16802

The Bid envelope, at lower left corner, shall bear the following identifying notation:

Bid For: [State the Contract Type and Number]

Project: [State the Project Title]

Project No.: [State the Project Number]

Bid Date: [State the Bid Date]

Submitted by: [State the Bidder’s Name]

Proposals which do not conform to these requirements, or which contain additions, conditional bids, or irregularities of any kind, may be rejected.

9. MODIFICATIONS OF BIDS. Any Bidder may modify its bid by telegraphic communication (fax #814-865-1692) at any time prior to the scheduled closing time for receipt of bids, provided such telegraphic communication is received by the Owner prior to the closing time, and provided further, that the Owner is satisfied that a written confirmation of the telegraphic modification over the signature of the Bidder was mailed prior to the closing time.

The telegraphic modification communication must not reveal the Bid Price but should provide the addition or subtraction or other modification so that the final prices or terms will not be known by the Owner until the Sealed Bid is opened. If written confirmation is not received within two (2) days from the closing time, no consideration will be given to the telegraphic modification.

10. BID SUBMITTAL. Any bid submitted may be withdrawn prior to the scheduled time for opening or authorized postponement thereof.

Regardless of the method used for delivery of bids to Room 106 of the Physical Plant (OPP) Building, it is strictly the responsibility of the submitting contractor to insure the bid is submitted by 3PM sharp. No bid will be accepted after 3pm. [C]

**ANY BID RECEIVED AFTER THE TIME AND DATE SPECIFIED WILL NOT BE CONSIDERED.**

No Bidder may withdraw a bid within sixty (60) days after the actual opening thereof.
BEFORE SUBMITTING A PROPOSAL, The Bidder should CAREFULLY EXAMINE ALL of the Drawings, Schedules, and Specifications, VISIT THE SITE, fully inform itself as to all laws, ordinances, regulations, wage rates, and labor conditions in the area of operation affecting the Contract or the work, and shall include in his proposal a sum to cover the cost of all items, implied or required, to attain the completed conditions contemplated by the Contract Documents.

THE OWNER DOES NOT OBLIGATE ITSELF to accept the lowest proposal or any proposal, and reserves the right to waive any informalities in any or all bids, and to reject or accept any proposal.

11. BIDDERS SHALL AGREE, if awarded the contract for the work, to execute a separate agreement for the work proposed. The Agreement, as a Lump Sum Contract, shall be executed on the standard Form of Agreement DGS 1-C bound (sample) with the Contract Documents.

BIDDERS SHALL AGREE, if awarded the Contract, to commence work at the site within ten (10) days after date of “Notice to Proceed,” and to complete the entire work on or before the Completion Date stipulated hereinbefore.

12. TIME OF COMPLETION – LIQUIDATED DAMAGES. Contractor must agree to begin work contemplated by this contract within ten (10) days after the date specified in the Notice to Proceed as the starting date and to complete the work on or before the completion dates indicated in section A, item #2 subject to extension of Contract time as provided in Article 10 of the General Conditions. Contractor must agree to pay to the Owner as liquidated damages and not as a penalty, the sum of five hundred dollars ($500.00) per calendar day for each calendar day of delay. The Contractor and its surety shall be liable for the amount thereof.

The basis for liquidated damages for the Abatement contract (#800-290.HA1.1) and the Demolition contract (#800-290.BD2.1) will be the completion dates indicated in Section A, item #2 above. For all other contracts the basis for liquidated damages will be based on the substantial completion date listed in Section A, item #2 above as well as the master project schedule including the 2 week look ahead updates. The project schedule process is outlined further in Section F.

13. Local Building Permit costs shall not be included in the Contract Amount. PSU will provide the required building permits.

14. TO VISIT THE SITE, due to the ongoing operations of the Henderson Building, the University is limiting Prebid site visits to the walkthrough scheduled to commence following the Prebid Conference as described in item #3 above.

15. PREBID REQUESTS FOR INFORMATION: In the case that the Bidder finds discrepancies or omissions in, or is in doubt as to the meaning of the drawings or contract documents, the Bidder shall at once make inquiry to the Construction Manager, who will send answers in the form of Addenda to all Bidders via the Online Plan Room. The RFI form will be available for download on the Online Plan Room and is the required form for all Prebid RFI’s. Information requests not on this form may not be addressed.

All correspondence shall be directed to:

Brian Frye
bfrye@massarocorporation.com

To receive attention, such inquiries must be received by Massaro CM Services, LLC no later than noon ten (10) days prior to the Bid Date.
16. **EQUAL EMPLOYMENT OPPORTUNITY AND REFERRAL TO NON-DISCRIMINATION CLAUSE**

In performing the work or making or furnishing any article required by this Contract, the Contractor shall comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended by Executive Order No. 11375 of October 13, 1967, and all subsequent rules, regulations, and relevant orders of the Secretary of Labor. The Contractor will comply with all provisions of Executive Order 1972-1 or any regulations issued by the Pennsylvania Human Relations Commission, 16 Pa. Code, Chapter 49. The Non-Discrimination Clause as issued by the Pennsylvania Human Relations Commission is attached as Article 13 of the General Conditions of the Contract.

17. **PREVAILING WAGE ACT**

This project is subject to the Pennsylvania Prevailing Wage Act, Act NO. 442, August 15, 1961 (P.L. 987), as amended August 9, 1963, Act No. 342. All Contractors and Subcontractors shall comply with all requirements of this Act. Refer to Sections D and D1 of this specification for additional information.

18. **STEEL PRODUCTS PROCUREMENT ACT**

   a. This Project is subject to the provisions of the Steel Products Procurement Act of 1978 (P.L. 6, No. 3) as amended by the Act of July 9, 1984 (P.L. 674, No. 144). All Contractors, Subcontractors, and Material Suppliers shall be required to comply with all provisions of this Act.

   b. The Contractor shall be required to provide with each Application-Certificate of Payment form an executed copy of the Certification of Compliance with the Steel Products Procurement Act form and additional documentation, including but not limited to, invoices, bills of lading, mill certifications, or other acceptable evidence that the steel products represented on the payment application comply with one or more of the following categories:

      1. That the steel utilized on this project was melted and manufactured in the United States; and/or

      2. The product contains both foreign and United States steel, and at least seventy-five percent (75%) of the cost of all of the articles, materials, and supplies incorporated in the product have been mined, produced, or manufactured, as the case may be, in the United States; and/or

      3. The steel product is not produced in the United States in sufficient quantities to meet the requirements of the contract, and prior written approval to use foreign steel has been obtained from The Pennsylvania State University.

   c. Any nonconforming steel products incorporated into the work shall be removed and replaced by the Contractor, at its own expense, with products meeting the requirements of the Act.

   d. Willful violation of this Act can result in penalties, including (but not necessarily limited to) prohibition from submitting any bids, or performing any work, or supplying any materials to a public agency for a period five (5) years from the date of the determination that a violation has occurred.

19. All work relating to this project shall be subject to all federal, state and local codes, ordinances and regulations regarding occupational safety and health, environmental protection and construction standards. Nothing contained in the specifications or the drawings shall be construed to conflict with such laws, codes, ordinances or regulations, and in the event of such conflict any requirement imposed by law, ordinance or regulation shall be deemed controlling.
20. LEAD-FREE PLUMBING CERTIFICATION. The Contractor shall provide a certification that all plumbing materials are lead-free and meet the requirements of the Pennsylvania Plumbing and Lead Ban Notification Act. This certification shall be signed by the Contractor, notarized and submitted to the University before the water service turn-on.

21. MINORITY AND WOMEN BUSINESS ENTERPRISES. Refer to Exhibit I for specific MBE/WBE participation levels. Minority participation and/or solicitation is required for the bid to be considered responsive. MBE/WBE Certification/Participation Forms 16A and 16B contained in Section B “Form of Proposal” must be completed and included with the bid documents. Any questions on completing the required paperwork should be addressed to Mr. Vernon L. Davis, Contractor Liaison, at (814) 863-2520 or vld3@psu.edu.

Each Prime Contractor will be required to include with all Applications for Payment, a form (developed by MCMS) documenting MBE/WBE participation levels. This form will be reviewed as part of the payment application process by MCMS and PSU to verify MBE/WBE required participation levels are being achieved and maintained.

22. CONTRACTOR RESPONSIBILITY. Exhibit D “Tax Liability Provisions” provides information pertaining to the Commonwealth of Pennsylvania Department of General Services certification. This certification process requires each bidder to have a Vendor ID. A Vendor ID may be obtained through the following web link titled “Central Vendor Management Unit (CVMU)”.

http://www.vendorregistration.state.pa.us/cvmu/paper/default.aspx
Click on the “Procurement Vendor Registration Form” to complete the registration process.

END OF SECTION
SECTION B

FORM OF PROPOSAL

1. In compliance with the Notice to Bidders and the Contract Documents, we, the undersigned, do hereby agree to provide all labor, materials, services, tools, and equipment, and to perform all of the required work to complete the:

   For the: Hazardous Building Materials Abatement                  DGS Contract # 800-290.HA1.1

   PSU Project Official name – Henderson Addition – Biobehavioral Health Building

   DGS Project No. 800-290
   PSU Project No. 06-42744
   Located at:

   The Pennsylvania State University
   University Park Campus
   University Park, Pennsylvania

   For:                 The Pennsylvania State University, Owner

   All in strict accordance with the Specifications, Schedules, Drawings, and Conditions for the consideration of the following amounts, including federal, state, and all applicable taxes, for the sum of:

   Bid Item No. 1 – Base Bid                                         $ __________________________________________________________________

   (write in dollar amount using words)

2. Alternates:
   NO ALTERNATES REQUESTED

3. We, the undersigned, agree, if awarded the Contract, to execute an agreement for the above-stated work and compensation on the standard Form of Agreement DGS 1-C.

4. We, the undersigned, agree, if awarded the Contract, to begin work at the site within ten (10) days after Notice to Proceed, and to complete the work in a thoroughly good and workmanlike manner under the direction of the Architect and to the satisfaction of the Owner, on or before the Completion Dates as stated in Section A.
5. We, the undersigned, acknowledge receipt of and have considered in our proposal the following Addenda and RFI’s:

Addendum #1

Addendum #2

RFI# PC001 thru RFI# PC153

Addendum #3

Addendum #4

Addendum #5

6. Unit Prices:

Unit Price #1 – All items as indicated in Section H6 (see attached form)

7. Bid results will be available on the web at <http://www.opp.psu.edu>.

8. We, the undersigned, acknowledge that both the Penn State and Massaro CM Services pre-qualification processes were completed in their entirety within the timeframe outlined in Section H7 of the bidding documents.

9. We, the undersigned, acknowledge that MBE/WBE Forms 16A and 16B are completed and included as part of this bid. It is understood that failure to comply may result in rejection of the bid.

10. We, the undersigned, agree that this Proposal as submitted shall hold good through the sixtieth (60th) day following the bid date:

Submitted By: ________________________________
Federal ID Number: ________________________________
PA Vendor Number: ________________________________
Address: _______________________________________

_______________________________________________
Signed By: Authorized Signature

Attest: _________________________________________

Surety Name: ______________________________________
Surety Address: ______________________________________

Date: _________________________________________
SECTION B

FORM OF PROPOSAL

1. In compliance with the Notice to Bidders and the Contract Documents, we, the undersigned, do hereby agree to provide all labor, materials, services, tools, and equipment, and to perform all of the required work to complete the:

For the: Building Demolition DGS Contract # 800-290.BD2.1

PSU Project Official name – Henderson Addition – Biobehavioral Health Building

DGS Project No. 800-290
PSU Project No. 06-42744

Located at:

The Pennsylvania State University
University Park Campus
University Park, Pennsylvania

For: The Pennsylvania State University, Owner

All in strict accordance with the Specifications, Schedules, Drawings, and Conditions for the consideration of the following amounts, including federal, state, and all applicable taxes, for the sum of:

Bid Item No. 1 – Base Bid $ (write in dollar amount using words)

2. Alternates:
NO ALTERNATES REQUESTED.

3. We, the undersigned, agree, if awarded the Contract, to execute an agreement for the above-stated work and compensation on the standard Form of Agreement DGS 1-C.

4. We, the undersigned, agree, if awarded the Contract, to begin work at the site within ten (10) days after Notice to Proceed, and to complete the work in a thoroughly good and workmanlike manner under the direction of the Architect and to the satisfaction of the Owner, on or before the Completion Dates as stated in Section A.
5. We, the undersigned, acknowledge receipt of and have considered in our proposal the following Addenda and RFI's:

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<td>RFI# PC001 thru RFI# PC153</td>
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<td>Addendum #3</td>
</tr>
<tr>
<td>Addendum #4</td>
</tr>
<tr>
<td>Addendum #5</td>
</tr>
</tbody>
</table>

6. Unit Prices:

NO UNIT PRICING REQUESTED

7. Bid results will be available on the web at <http://www.opp.psu.edu>.

8. We, the undersigned, acknowledge that both the Penn State and Massaro CM Services pre-qualification processes were completed in their entirety within the timeframe outlined in Section H7 of the bidding documents.

9. We, the undersigned, acknowledge that MBE/WBE Forms 16A and 16B are completed and included as part of this bid. It is understood that failure to comply may result in rejection of the bid.

10. We, the undersigned, agree that this Proposal as submitted shall hold good through the sixtieth (60th) day following the bid date:

Submitted By:  _______________________________________________________
Federal ID Number: ___________________________________________________
PA Vendor Number: ___________________________________________________
Address:   _______________________________________________________

Signed By:  _______________________________________________________
Authorized Signature

Attest:   _______________________________________________________
Surety Name: _______________________________________________________
Surety Address: ____________________________________________________

Date:   _______________________________________________________
SECTION B

FORM OF PROPOSAL

1. In compliance with the Notice to Bidders and the Contract Documents, we, the undersigned, do hereby agree to provide all labor, materials, services, tools, and equipment, and to perform all of the required work to complete the:

For the: General Trades DGS Contract # 800-290.GC3.1

PSU Project Official name – Henderson Addition – Biobehavioral Health Building
DGS Project No. 800-290
PSU Project No. 06-42744

Located at: The Pennsylvania State University
University Park Campus
University Park, Pennsylvania

For: The Pennsylvania State University, Owner

All in strict accordance with the Specifications, Schedules, Drawings, and Conditions for the consideration of the following amounts, including federal, state, and all applicable taxes, for the sum of:

Bid Item No. 1 – Base Bid $ (write in dollar amount using words)

2. Alternates:

Alternate # 1 – Brick Wall Veneer $ (write in dollar amount using words)

Alternate # 2 – Limestone Wall Veneer $ (write in dollar amount using words)

3. We, the undersigned, agree, if awarded the Contract, to execute an agreement for the above-stated work and compensation on the standard Form of Agreement DGS 1-C.

4. We, the undersigned, agree, if awarded the Contract, to begin work at the site within ten (10) days after Notice to Proceed, and to complete the work in a thoroughly good and workmanlike manner under the direction of the Architect and to the satisfaction of the Owner, on or before the Completion Dates as stated in Section A.
5. We, the undersigned, acknowledge receipt of and have considered in our proposal the following Addenda and RFI's:
   Addendum #1
   Addendum #2
   Addendum #3
   Addendum #4
   Addendum #5

6. Unit Prices:
   Unit Price #2 - Rock Excavation and Removal (add or deduct per cubic yard measured in place)
   $ / CY
   Unit Price #3 - Partial Depth Concrete Spall Repair – cost per Cubic Foot
   $ / CF

7. Bid results will be available on the web at <http://www.opp.psu.edu>.

8. We, the undersigned, acknowledge that the Massaro CM Services pre-qualification process was completed in its entirety within the timeframe outlined in Section H7 of the bidding documents.

9. We, the undersigned, acknowledge that MBE/WBE Forms 16A and 16B are completed and included as part of this bid. It is understood that failure to comply may result in rejection of the bid.

10. We, the undersigned, agree that this Proposal as submitted shall hold good through the sixtieth (60th) day following the bid date:

Submitted By: _______________________________________________________
Federal ID Number: _______________________________________________________
PA Vendor Number: _______________________________________________________
Address: _______________________________________________________________
_______________________________________________________
Signed By: _______________________________________________________
   Authorized Signature
Attest: ________________________________________________________________
Surety Name: ___________________________________________________________
Surety Address: _________________________________________________________
_______________________________________________________
Date: ________________________________________________________________
SECTION B

FORM OF PROPOSAL

1. In compliance with the Notice to Bidders and the Contract Documents, we, the undersigned, do hereby agree to provide all labor, materials, services, tools, and equipment, and to perform all of the required work to complete the:

For the: Fire Protection DGS Contract # 800-290.5

PSU Project Official name – Henderson Addition – Biobehavioral Health Building

DGS Project No. 800-290
PSU Project No. 06-42744
Located at:

The Pennsylvania State University
University Park Campus
University Park, Pennsylvania

For: The Pennsylvania State University, Owner

All in strict accordance with the Specifications, Schedules, Drawings, and Conditions for the consideration of the following amounts, including federal, state, and all applicable taxes, for the sum of:

Bid Item No. 1 – Base Bid $ (write in dollar amount using words)

2. Alternates:
   NO ALTERNATES REQUESTED.

3. We, the undersigned, agree, if awarded the Contract, to execute an agreement for the above-stated work and compensation on the standard Form of Agreement DGS 1-C.

4. We, the undersigned, agree, if awarded the Contract, to begin work at the site within ten (10) days after Notice to Proceed, and to complete the work in a thoroughly good and workmanlike manner under the direction of the Architect and to the satisfaction of the Owner, on or before the Completion Dates as stated in Section A.
5. We, the undersigned, acknowledge receipt of and have considered in our proposal the following Addenda and RFI’s:

   Addendum #1
   Addendum #2
   RFI# PC001 thru RFI# PC153
   Addendum #3
   Addendum #4

6. Unit Prices:

   NO UNIT PRICING REQUESTED

7. Bid results will be available on the web at <http://www.opp.psu.edu>.

8. We, the undersigned, acknowledge that the Massaro CM Services pre-qualification process was completed in its entirety within the timeframe outlined in Section H7 of the bidding documents.

9. We, the undersigned, acknowledge that MBE/WBE Forms 16A and 16B are completed and included as part of this bid. It is understood that failure to comply may result in rejection of the bid.

10. We, the undersigned, agree that this Proposal as submitted shall hold good through the sixtieth (60th) day following the bid date:

    Submitted By: _______________________________________________________
    Federal ID Number: ___________________________________________________
    PA Vendor Number: ___________________________________________________ 
    Address:   _______________________________________________________
    _________________________________________________________

    Signed By:   _______________________________________________________
    Authorized Signature

    Attest:   _______________________________________________________

    Surety Name:   _______________________________________________________
    Surety Address: _____________________________________________________
    _________________________________________________________

    Date:   _______________________________________________________

SECTION B

FORM OF PROPOSAL

1. In compliance with the Notice to Bidders and the Contract Documents, we, the undersigned, do hereby agree to provide all labor, materials, services, tools, and equipment, and to perform all of the required work to complete the:

For the: Plumbing                                DGS Contract # 800-290.3

PSU Project Official name – Henderson Addition – Biobehavioral Health Building

DGS Project No. 800-290
PSU Project No. 06-42744

Located at:

The Pennsylvania State University
University Park Campus
University Park, Pennsylvania

For: The Pennsylvania State University, Owner

All in strict accordance with the Specifications, Schedules, Drawings, and Conditions for the consideration of the following amounts, including federal, state, and all applicable taxes, for the sum of:

Bid Item No. 1 – Base Bid $ ____________________

(write in dollar amount using words)

2. Alternates:
NO ALTERNATES REQUESTED.

3. We, the undersigned, agree, if awarded the Contract, to execute an agreement for the above-stated work and compensation on the standard Form of Agreement DGS 1-C.

4. We, the undersigned, agree, if awarded the Contract, to begin work at the site within ten (10) days after Notice to Proceed, and to complete the work in a thoroughly good and workmanlike manner under the direction of the Architect and to the satisfaction of the Owner, on or before the Completion Dates as stated in Section A.
5. We, the undersigned, acknowledge receipt of and have considered in our proposal the following Addenda and RFI’s:

Addendum #1

Addendum #2

RFI# PC001 thru RFI# PC153

Addendum #3

Addendum #4

6. Unit Prices:

NO UNIT PRICING REQUESTED

7. Bid results will be available on the web at <http://www.opp.psu.edu>.

8. We, the undersigned, acknowledge that the Massaro CM Services pre-qualification process was completed in its entirety within the timeframe outlined in Section H7 of the bidding documents.

9. We, the undersigned, acknowledge that MBE/WBE Forms 16A and 16B are completed and included as part of this bid. It is understood that failure to comply may result in rejection of the bid.

10. We, the undersigned, agree that this Proposal as submitted shall hold good through the sixtieth (60th) day following the bid date:

Submitted By:  _______________________________________________________

Federal ID Number: ___________________________________________________

PA Vendor Number: ___________________________________________________

Address:   _______________________________________________________

______________________________

Signed By:  _______________________________________________________

Authorized Signature

Attest:   _______________________________________________________

Surety Name:  _______________________________________________________

Surety Address:  ___________________________________________________

______________________________

Date:   _______________________________________________________

SECTION B

FORM OF PROPOSAL

1. In compliance with the Notice to Bidders and the Contract Documents, we, the undersigned, do hereby agree to provide all labor, materials, services, tools, and equipment, and to perform all of the required work to complete the:

For the: HVAC  
DGS Contract # 800-290.2

PSU Project Official name – Henderson Addition – Biobehavioral Health Building

DGS Project No. 800-290  
PSU Project No. 06-42744

Located at:

The Pennsylvania State University  
University Park Campus  
University Park, Pennsylvania

For: The Pennsylvania State University, Owner

All in strict accordance with the Specifications, Schedules, Drawings, and Conditions for the consideration of the following amounts, including federal, state, and all applicable taxes, for the sum of:

Bid Item No. 1 – Base Bid $ ______

________________________________________________________

(write in dollar amount using words)

2. Alternates:  
NO ALTERNATES REQUESTED.

3. We, the undersigned, agree, if awarded the Contract, to execute an agreement for the above-stated work and compensation on the standard Form of Agreement DGS 1-C.

4. We, the undersigned, agree, if awarded the Contract, to begin work at the site within ten (10) days after Notice to Proceed, and to complete the work in a thoroughly good and workmanlike manner under the direction of the Architect and to the satisfaction of the Owner, on or before the Completion Dates as stated in Section A.
5. We, the undersigned, acknowledge receipt of and have considered in our proposal the following Addenda and RFI's:

Addendum #1

Addendum #2

RFI# PC001 thru RFI# PC153

Addendum #3

Addendum #4

6. Unit Prices:

NO UNIT PRICING REQUESTED

7. Bid results will be available on the web at <http://www.opp.psu.edu>.

8. For the HVAC prime contract work, we, the undersigned, acknowledge that the Massaro CM Services prequalification process was completed in its entirety within the timeframe outlined in Section H7 of the bidding documents. We, the undersigned, acknowledge that the Penn State prequalification (for University Park) process was completed in entirety for the party to be engaged, whether self performed or sub-contracted, for the performance of the Building Automation System (BAS) work within this prime contract. The requirements and timeframe outlined in Section H7 of the bidding documents were observed.

9. We, the undersigned, acknowledge that MBE/WBE Forms 16A and 16B are completed and included as part of this bid. It is understood that failure to comply may result in rejection of the bid.

10. We, the undersigned, agree that this Proposal as submitted shall hold good through the sixtieth (60th) day following the bid date:

Submitted By: _______________________________________________________

Federal ID Number: ___________________________________________________

PA Vendor Number: ___________________________________________________

Address: _____________________________________________________________

Signed By: ___________________________________________________________

Authorized Signature

Attest: _______________________________________________________________

Surety Name: _________________________________________________________

Surety Address: _______________________________________________________
SECTION B

FORM OF PROPOSAL

1. In compliance with the Notice to Bidders and the Contract Documents, we, the undersigned, do hereby agree to provide all labor, materials, services, tools, and equipment, and to perform all of the required work to complete the:

For the: Electric DGS Contract # 800-290.EL1.4

PSU Project Official name – Henderson Addition – Biobehavioral Health Building

DGS Project No. 800-290
PSU Project No. 06-42744

Located at:

The Pennsylvania State University
University Park Campus
University Park, Pennsylvania

For: The Pennsylvania State University, Owner

All in strict accordance with the Specifications, Schedules, Drawings, and Conditions for the consideration of the following amounts, including federal, state, and all applicable taxes, for the sum of:

Bid Item No. 1 – Base Bid $ ____________________________

(Write in dollar amount using words)

2. Alternates:

Alternate #3 – Low Voltage Transformer Efficiency $ ____________________________

(Write in dollar amount using words)

3. We, the undersigned, agree, if awarded the Contract, to execute an agreement for the above-stated work and compensation on the standard Form of Agreement DGS 1-C.

4. We, the undersigned, agree, if awarded the Contract, to begin work at the site within ten (10) days after Notice to Proceed, and to complete the work in a thoroughly good and workmanlike manner under the direction of the Architect and to the satisfaction of the Owner, on or before the Completion Dates as stated in Section A.
5. We, the undersigned, acknowledge receipt of and have considered in our proposal the following Addenda and RFI's:

   Addendum #1
   Addendum #2
   RFI# PC001 thru RFI# PC153
   Addendum #3
   Addendum #4
   Addendum #5

6. Unit Prices:

   NO UNIT PRICING REQUESTED

7. Bid results will be available on the web at <http://www.opp.psu.edu>.

8. We, the undersigned, acknowledge that the Massaro CM Services pre-qualification process was completed in its entirety within the timeframe outlined in Section H7 of the bidding documents.

9. We, the undersigned, acknowledge that MBE/WBE Forms 16A and 16B are completed and included as part of this bid. It is understood that failure to comply may result in rejection of the bid.

10. We, the undersigned, agree that this Proposal as submitted shall hold good through the sixtieth (60th) day following the bid date:

    Submitted By:  _______________________________________________________
    Federal ID Number: _____________________________________________________
    PA Vendor Number: _____________________________________________________
    Address:   _______________________________________________________
                _______________________________________________________
    Signed By:  _______________________________________________________
                 Authorized Signature
    Attest:   _______________________________________________________
    Surety Name: _______________________________________________________
    Surety Address: _______________________________________________________
    Date:   _______________________________________________________

SECTION B

FORM OF PROPOSAL

1. In compliance with the Notice to Bidders and the Contract Documents, we, the undersigned, do hereby agree to provide all labor, materials, services, tools, and equipment, and to perform all of the required work to complete the:

For the: Telecommunications DGS Contract # 800-290.TL2.4

PSU Project Official name – Henderson Addition – Biobehavioral Health Building

DGS Project No. 800-290
PSU Project No. 06-42744

Located at:

The Pennsylvania State University
University Park Campus
University Park, Pennsylvania

For: The Pennsylvania State University, Owner

All in strict accordance with the Specifications, Schedules, Drawings, and Conditions for the consideration of the following amounts, including federal, state, and all applicable taxes, for the sum of:

Bid Item No. 1 – Base Bid $ ________________

(write in dollar amount using words)

2. Alternates:
NO ALTERNATES REQUESTED.

3. We, the undersigned, agree, if awarded the Contract, to execute an agreement for the above-stated work and compensation on the standard Form of Agreement DGS 1-C.

4. We, the undersigned, agree, if awarded the Contract, to begin work at the site within ten (10) days after Notice to Proceed, and to complete the work in a thoroughly good and workmanlike manner under the direction of the Architect and to the satisfaction of the Owner, on or before the Completion Dates as stated in Section A.
5. We, the undersigned, acknowledge receipt of and have considered in our proposal the following Addenda and RFI’s:

Addendum #1

Addendum #2

RFI# PC001 thru RFI# PC153

Addendum #3

Addendum #4

Addendum #5

6. Unit Prices:

NO UNIT PRICING REQUESTED

7. Bid results will be available on the web at <http://www.opp.psu.edu>.

8. We, the undersigned, acknowledge that both the Penn State and Massaro CM Services pre-qualification processes were completed in their entirety within the timeframe outlined in Section H7 of the bidding documents.

9. We, the undersigned, acknowledge that MBE/WBE Forms 16A and 16B are completed and included as part of this bid. It is understood that failure to comply may result in rejection of the bid.

10. We, the undersigned, agree that this Proposal as submitted shall hold good through the sixtieth (60th) day following the bid date:

Submitted By: _______________________________________________________

Federal ID Number: ____________________________________________________

PA Vendor Number: ____________________________________________________

Address: _____________________________________________________________

Signed By: ____________________________________________________________

Authorized Signature

Attest: _________________________________________________________________

Surety Name: __________________________________________________________

Surety Address: _________________________________________________________

Date: _________________________________________________________________
SECTION B

FORM OF PROPOSAL

1. In compliance with the Notice to Bidders and the Contract Documents, we, the undersigned, do hereby agree to provide all labor, materials, services, tools, and equipment, and to perform all of the required work to complete the:

For the: Landscaping  
DGS Contract # 800-290.LA4.1

PSU Project Official name – Henderson Addition – Biobehavioral Health Building

DGS Project No. 800-290  
PSU Project No. 06-42744

Located at:

The Pennsylvania State University  
University Park Campus  
University Park, Pennsylvania

For: The Pennsylvania State University, Owner

All in strict accordance with the Specifications, Schedules, Drawings, and Conditions for the consideration of the following amounts, including federal, state, and all applicable taxes, for the sum of:

Bid Item No. 1 – Base Bid $ (write in dollar amount using words)

2. Alternates:  
NO ALTERNATES REQUESTED.

3. We, the undersigned, agree, if awarded the Contract, to execute an agreement for the above-stated work and compensation on the standard Form of Agreement DGS 1-C.

4. We, the undersigned, agree, if awarded the Contract, to begin work at the site within ten (10) days after Notice to Proceed, and to complete the work in a thoroughly good and workmanlike manner under the direction of the Architect and to the satisfaction of the Owner, on or before the Completion Dates as stated in Section A.
5. We, the undersigned, acknowledge receipt of and have considered in our proposal the following Addenda and RFI’s:

- Addendum #1
- Addendum #2
- RFI# PC001 thru RFI# PC153
- Addendum #3
- Addendum #4
- Addendum #5

6. Unit Prices:

Landscape Prime Contractor will be required to submit unit pricing (within 30 days of receiving a contract) for plant material type and size to the Construction Manager.

7. Bid results will be available on the web at <http://www.opp.psu.edu>.

8. We, the undersigned, acknowledge that the Massaro CM Services pre-qualification process was completed in its entirety within the timeframe outlined in Section H7 of the bidding documents.

9. We, the undersigned, acknowledge that MBE/WBE Forms 16A and 16B are completed and included as part of this bid. It is understood that failure to comply may result in rejection of the bid.

10. We, the undersigned, agree that this Proposal as submitted shall hold good through the sixtieth (60th) day following the bid date:

Submitted By:  _______________________________________________________

Federal ID Number: ___________________________________________________

PA Vendor Number: ___________________________________________________

Address:   _______________________________________________________

_______________________________________________________

Signed By:  _______________________________________________________

Authorized Signature

Attest:   _______________________________________________________

Surety Name:  _______________________________________________________

Surety Address:  ___________________________________________________

_______________________________________________________

Date:   _______________________________________________________
Commonwealth of Pennsylvania  
Department of General Services  
GSMWBE-16 (8/04)

MBE/WBE SUBCONTRACTOR AND SUPPLIER CERTIFICATION, 
SOLICITATION AND COMMITMENT FORM

This form, GSMWBE-16 (Form 16), is comprised of two parts: 16A - Certification and 16B - Record of MBE/WBE Solicitations and Commitments. Instructions on how to complete both parts of this form are provided at the end of this document.

FORM 16A – CERTIFICATION

This Form 16A must be completed and signed by the each bidder and submitted with its bid.

Bidder name: ____________________________________________

Project #: ____________________________________________

☐ 1. We commit to meet the MPLs for the project as stated in the Notice to Bidders for:
   MBEs Yes ___  No ___
   WBEs Yes ___  No ___

If the answer for both MBEs and WBEs is "Yes" GO DIRECTLY TO THE SIGNATURE LINES AT THE END OF THIS CERTIFICATION. YOU DO NOT NEED TO COMPLETE THE REMAINDER OF THIS FORM AND YOU DO NOT NEED TO COMPLETE FORM 16B.

If either answer is "No" you must check and complete either statement 2 or 3 below, sign this form and complete Form 16B.

☐ 2. We do not commit to meet both MPLs as stated in the Notice to Bidders. However, we did meet the minimum solicitation requirements (5 MBE subcontractors and 5 WBE subcontractors from the "Work Area" as defined in the Instructions to Bidders Section A.31 and 5 MBE suppliers and 5 WBE suppliers) and we commit to the following participation levels:
   MBEs _____ %  WBEs _____ %

☐ We have included below an explanation of our failure to commit to both MPLs. (Attach additional sheets as necessary.)

   MBE: ____________________________________________
   WBE: ____________________________________________

☐ We have completed and included with our bid the Form 16B - Record of MBE/WBE Solicitations and Commitments.

☐ We included with our bid all additional documentation as required in the Form 16 - Instructions and the Instructions to Bidders Section A.31.

☐ We conducted all initial MBE/WBE solicitations at least five (5) business days in advance of the bid opening day.

Failure to check all boxes under this statement 2, to indicate the MBE/WBE participation levels, and to provide a satisfactory explanation shall result in the rejection of your bid as not responsive.
Commonwealth of Pennsylvania
Department of General Services
GSMWBE-16 (8/04)

☐ 3. We do not commit to meet both MPLs as stated in the Notice to Bidders and we did not meet the minimum solicitation requirements (5 MBE subcontractors and 5 WBE subcontractors from the "Work Area" as defined in the Instructions to Bidders Section A.31 and 5 MBE suppliers and 5 WBE suppliers); however, we do commit to the following participation levels:

  MBEs _____ %  WBEs _____ %

☐ We have included below an explanation of our failure to commit to both MPLs. (Attach additional sheets as necessary.)

  MBE: ____________________________________________

  WBE: ____________________________________________

☐ We have included below an explanation for our failure to comply with the minimum solicitation requirements. For example, if you do not intend to use any subcontractors you may state that fact as your reason for noncompliance. Complete as many as are appropriate. (Attach additional sheets as necessary.)

  MBE subcontractors ____________________________________

  WBE subcontractors ____________________________________

  MBE suppliers ________________________________________

  WBE suppliers ________________________________________

☐ To the extent that we have solicited MBEs and WBEs, we have completed and included with our bid the Form 16B - Record of MBE/WBE Solicitations and Commitments.

☐ We have included with our bid all additional documentation as required in the Form 16 - Instructions and the Instructions to Bidders Section A.31.

☐ We conducted all initial MBE/WBE solicitations at least five (5) business days in advance of the bid opening day.

Failure to check all boxes under this statement 3, to indicate the MBE/WBE participation levels, and to provide satisfactory explanations shall result in the rejection of your bid as not responsive.

**Signature Certification**

I certify that the information on this form is true and correct to the best of my knowledge and that I am authorized to represent the above-named Bidder in connection with this certification.

Signature: ____________________________________________

Name (print or type): ____________________________________

Titles: ________________________________________________
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<thead>
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<td>E-Mail Address:</td>
<td></td>
</tr>
<tr>
<td>Contact Person:</td>
<td></td>
</tr>
</tbody>
</table>

**Note to Bidders:**

In completing this form, the Bidder must comply with the Form 16 - Instructions and the Instruction for Bidders Section A.31. The following is provided for informational purposes only.

1. If you commit in your bid to meet the MPLs for both MBEs and WBEs you do **not** need to complete this Form 16B.
2. If you do not commit in your bid to meet both MPLs you must complete this Form 16B and submit all additional documentation as required by the Instruction to Bidders Section A.31 and as described in the Form 16 - Instructions. Failure to do so will be sufficient cause for rejection of the bid as NOT RESPONSIVE.
3. In completing Form 16B, the Bidder shall (see Form 16 - Instructions and Instructions to Bidders Section A.31 for complete detail):
   a. solicit a **minimum** of 5 Subcontractors-MBE, 5 Subcontractors-WBE, 5 Suppliers-MBE **and** 5 Suppliers-WBE;
   b. initiate all solicitation at least five (5) business days prior to the bid opening date;
   c. solicit MBE and WBE subcontractors within the Work Area, as defined in the Instructions to Bidders Section A.31, and
   d. record on Form 16B information pertaining to all solicitations, quotes (solicited and unsolicited) and commitments from MBE and WBE firms.
4. By submitting this form, the Bidder certifies that it has solicited the MBE and WBE firms for all services for which it intends to enter into a subcontract and for all supplies for which it intends to purchase within the Contract scope of work.
FORM 16 - INSTRUCTIONS

1.0 Purpose
The purpose of Form GSMWBE-16 (Form 16) is to secure documentation that ensures that the Bidder has not discriminated against MBE and WBE subcontractors and suppliers in the Bidder’s solicitation of and commitments to subcontractors and suppliers. Form 16 is comprised of two parts: 16A – Certification and 16B - Record of MBE/WBE Solicitations and Commitments as well as these instructions. Before completing Form 16, the Department of General Services (Department) strongly encourages the Bidder to review the Instruction to Bidders Section A.31: Minority Business and Women Business Enterprise Participation for further instruction on completing Form 16 and consequences for providing incomplete or incorrect information.

2.0 Instructions for Form 16A – Certification
All Bidders must complete, sign and submit Form 16A - Certification (Form 16A) with their bids.

Instructions for Statement 1
Check box 1 and complete statement 1, if you commit to meet both MPLs for the project or if you commit to meet the MPL for either MBEs or WBEs.

A Bidder who commits to meet both the MPLs for MBEs and WBEs only needs to check the “yes” box for both MBEs and WBEs, and to have an authorized representative of the company sign the form. If the Bidder is selected for award, the Bidder will be required to submit detailed information including but not limited to copies of quotes and any contracts or letters of intent documenting the Bidder’s commitment to the MPLs within ten calendar days after notice of award from the Department. Failure to provide the documentation, satisfactory to the Department, detailing commitments made to MBEs and WBEs within ten (10) calendar days after notice of award from the Department shall result in rejection of the bid as non-responsive and the Bidder’s bid security shall be forfeited to the Department as liquidated damages for the bid default.

A Bidder who commits to only one MPL is required to indicate which MPL and to complete the remaining portions of the Form 16A and Form 16B in compliance with the instructions provided herein and the Instructions to Bidders Section A.31.

Instructions for Statement 2
Check box 2 and complete statement 2 if you do not commit to meet both MPLs but you have complied with the minimum solicitation requirements: you have solicited proposals from a minimum of 5 MBEs and 5 WBEs for subcontracting from the "Work Area" as defined in the Instructions to Bidders Section A.31 and 5 MBEs and 5 WBEs for supplies.

A Bidder who does not commit to meet both MPLs but who meets the minimum solicitation requirements must:
1. Indicate the MBE and WBE participation levels that it has committed to in its bid.
2. Indicate by checking the first check box that it has provided in the space provided an explanation of its failure to commit to both MPLs. If the Bidder provides its explanation on a separate page it must indicate so in the space provided.
3. Indicate by checking the second check box that it has completed Form 16B.
4. Indicate by checking the third check box that it has included with its bid the additional documentation as required in these instructions and the Instructions to Bidders Section A.31.
5. Indicate by checking the fourth check box that it has conducted all initial MBE/WBE solicitations at least five (5) business days in advance of the bid opening day.
6. Have an authorized representative of the company sign Form 16A.
Commonwealth of Pennsylvania
Department of General Services
GSMWBE-16 (804)

Failure to properly complete and submit Forms 16A and 16B and to provide the additional documentation as required in the Instruction to Bidders Section A.31 with the bid shall result in the rejection of the bid.

**Instructions for Statement 3**

Complete statement 3 if you do not commit to meet both MPLs and you have not complied with the minimum solicitation requirements: you have not solicited proposals from a minimum of 5 MBEs and 5 WBEs for subcontracting from the "Work Area" as defined in the Instructions to Bidders Section A.31 and 5 MBEs and 5 WBE for supplies.

A Bidder who does not commit to both MPLs and who does not meet the minimum solicitation requirements must:

1. Indicate the MBE and WBE participation levels that it has committed to in its bid.
2. Indicate by checking the first check box that it has provided an explanation of its failure to commit to both MPLs. If the Bidder provides its explanation on a separate page it must indicate so in the space provided.
3. Indicate by checking the second check box that it has provided an explanation for not meeting the minimum solicitation requirements. If the Bidder provides its explanation on a separate page it must indicate so in the space provided.
4. Indicate by checking the third check box that it has completed Form 16B to the extent that it has solicited MBEs and WBEs and included it with its bid.
5. Indicate by checking the fourth check box that it has included with its bid the additional documentation as required in these instructions and the Instructions to Bidders Section A.31.
6. Indicate by checking the fifth check box that it has conducted all initial MBE/WBE solicitations at least five (5) business days in advance of the bid opening day.
7. Have an authorized representative of the company sign Form 16A.

Failure to properly complete and submit Forms 16A and 16B and to provide the additional documentation required in the Instruction to Bidders Section A.31 with the bid shall result in the rejection of the bid.

**3.0 Instructions for Form 16B - Record of MBE/WBE Solicitations and Commitments**

A Bidder who commits in its bid documents to meet the MPLs does not need to complete Form 16B. Form 16B must be completed by the Bidder who does not commit to meet both MPLs as set forth in the Notice to Bidders. **A Bidder completing form 16B must solicit and commit to Department certified MBEs and WBEs only.** Firms certified by any other entity will not be recognized for purposes of compliance with these instructions and the invitation for bids. The Department’s searchable database of certified MBE/WBE firms appears on the Department’s website:

http://www.dgsapp.state.pa.us/imaginepa/bcabd/vendor_search.asp?bcabdRNAvrad6BC2C=

**Instructions for Block 1**

Provide your company name, federal employer identification number, address, telephone number, fax number, e-mail address and contact person. The e-mail address should be for the person within your organization who handles contract compliance or EEO-related issues.

**Instructions for Block 2**

Provide the Department’s contract number, project name, county in which project is located, and total amount of the bid. If more than one base bid is submitted, provide the total bid amount for Base Bid #1.

**Instructions for Blocks 3 - 7**

3. Enter the subcontractor or supplier’s company name exactly as it appears on the Department’s website list of certified MBEs/WBEs. Do not use a D/B/A (Doing Business As) name. List the address, zip code, county, telephone number with area code, and contact person’s name.
Commonwealth of Pennsylvania  
Department of General Services  
GSMWBE-16 (8/04)  

4. Indicate whether the firm is a Department-certified MBE or WBE. If the firm is both a Department-certified MBE and a Department-certified WBE, the Bidder will receive credit for the firm as either an MBE or a WBE, at the Bidder’s determination. The Department shall count a firm toward only one category.

5. Briefly describe the specific type of work to be performed and/or materials to be supplied by the listed Department-certified MBE or WBE. In order to count towards reaching the MPLs, the Bidder must solicit Department-certified MBEs/WBEs for the goods and services for which they are certified. For example, if an MBE/WBE is Department-certified for electrical supplies and the Bidder lists plumbing supplies, the Bidder will not receive credit for that firm. Geographical location may not be used as a reason for limiting MBE/WBE solicitations.

6. Enter the total dollar ($) amount of any (solicited and non-solicited) quote received. If the quote was received in the form of unit prices or hourly rates, a total dollar amount must still be provided. If the solicited subcontractor did not respond to the Bidder, the Bidder must indicate “No Response.” Copies of all MBE/WBE quotes (solicited and unsolicited) must be submitted with the bid. In addition, the bidder must submit with its bid an example of its request for quotation issued to MBE and WBE contractors and suppliers.

7. Enter the total dollar ($) amount of the contractual commitment made to the listed MBE/WBE. If the Bidder does not commit to use the quote from a MBE/WBE because lower a priced quote was received, the Bidder must provide an explanation with its bid and submit a copy of the lower priced quote. On partial commitments, the Bidder must provide an explanation with its bid why it made only a partial commitment and must submit a copy of the lower priced quote.

4.6 The Bureau of Minority and Women Business Opportunities

The Bureau of Minority and Women Business Opportunities (BMWBO) is available for technical assistance to all Bidders submitting proposals for this contract. A listing of Department-certified MBEs and WBEs is incorporated in the contract documents. Department certification of an entity as an MBE/WBE means only that the applicant for certification has submitted information that qualifies it as an MBE/WBE in terms of its ownership and control. It does not imply, and no Bidder shall infer, that the Department has in any way investigated or approved the entity’s competence to perform work. Please direct your question to:

   Bureau of Minority and Women Business Opportunities  
   502 North Office Building  
   Harrisburg, Pennsylvania 17125  
   717-787-7380
MEMORANDUM

SUBJECT: Bureau of Minority and Women Business Opportunities (MBE/WBE) Minimum Levels

DATE: August 20, 2010

TO: Richard E. Tennent, RA
Design and Construction Division
The Pennsylvania State University

FROM: Kathryn Waters-Perez, Director
Bureau of Minority and Women Business Opportunities

In accordance with Executive Order No. 2004-6 the Bureau of Minority and Women Business Opportunities has established levels for MBE/WBE participation on the following project:

D.G.S. No.: 800-290.1.2.3.4.5
Project Name and Location: PSU Project No.: 06-42744.00
Henderson Addition
BioBehavioral Health Building
University Park, Centre County, PA

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<th>WBE</th>
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FORM OF AGREEMENT DGS 1-C
THE PENNSYLVANIA STATE UNIVERSITY
OWNER AND CONTRACTOR

CONTRACT

THIS AGREEMENT made this __________ day of _____________________________
in the year Two Thousand Nine (2009) _____________________________________
by and between

______________________________________________________________

hereinafter called the Contractor and THE PENNSYLVANIA STATE UNIVERSITY, a corporation created and
existing under the laws of the Commonwealth of Pennsylvania, hereinafter called the Owner for the following project:

______________________________________________________________

In consideration of the promises set forth herein, and with intent to be legally bound, the parties agree as follows:

ARTICLE 1: THE WORK AND THE DOCUMENTS FORMING THE CONTRACT

The Work forming the subject of this Construction Contract is shown on Drawings titled:

______________________________________________________________
It is described in the Specification, consisting of the General Conditions of the Contract, Articles 1 to 14 inclusive and:

The said Drawings and Specifications together with the General Conditions, as hereinabove described, are as fully a part hereof as if hereto attached or herein repeated.

ARTICLE 2: THE PROFESSIONAL

References to the Professional in any of the Contract Documents shall refer to the Professional whose name appears hereafter.

The Professional shall either be a person or firm lawfully licensed to practice architecture or engineering or the appropriate office of the Owner as noted.

ARTICLE 3: THE CONTRACTOR'S DUTIES AND STATUS

The Contractor agrees to furnish the labor, material, tools, machinery, equipment, facilities, and supplies to do all things necessary for the construction and completion of the Work; to furnish efficient business administration and superintendence; to have at the Work whenever needed and to keep upon it at all times an adequate supply of workmen and materials, and to secure its execution in the best, most workmanlike, expeditious and economical manner.

The Contractor, recognizing the relations of trust and confidence established between himself and the Owner by the terms of this Agreement, undertakes to furnish his best skill and judgment and to cooperate loyally with the Professional in forwarding the interests of the Owner, and to have no pecuniary interest, direct or indirect, in the Contract or in its performance other than as disclosed in this Agreement.
The Contractor agrees to begin the Work contemplated by this Contract within Ten (10) days after notice from the Owner to proceed and to substantially complete the same, ready for the Owner's occupancy and use, within ________ calendar days after said Notice. Contractor agrees to complete all punch list items within ________ calendar days of substantial completion. Contractor agrees that time is of the essence of this Contract and if he shall fail to complete the Work within the time above specified, or such extension or extensions thereof as shall be granted, the Contractor shall pay Owner, as liquidated damages and not as a penalty for such failure, the sum of ________________________ Dollars ($_______) per day for each and every calendar day thereafter until such Work shall be substantially completed and ready for the Owner's occupancy and use. Provided, nevertheless, if the Contractor is delayed at any time in the progress of the Work by any act or neglect of the Owner or Professional, or of any employee of either, or of a separate Contractor employed by the Owner, or by changes ordered in the Work, or by labor disputes, fire, unavoidable casualties or other causes beyond the Contractor's control, or by delay authorized by the Owner, or by other causes which the Professional determines may justify delay, then the Contract Time shall be extended by Change Order for such reasonable time as the Professional may determine with the Owner's approval.

ARTICLE 4: OWNER'S REPRESENTATION

The Owner shall appoint a representative, who shall act for the Owner in the execution of this Contract.

ARTICLE 5: CONTRACT SUM

In consideration of the completion by the Contractor of the Work contemplated in this Contract in strict accordance therewith, the Owner agrees to pay to the Contractor the sum of ________________________ Dollars ($_______), which sum is not to be increased or diminished except as provided in Article 9 of the General Conditions relative to Changes in the Work.

ARTICLE 6: METHODS OF PAYMENTS

The Contractor shall each month submit to the Owner a statement in detail showing the amount of Work performed in the preceding calendar month, according to Article 11 of the General Conditions. Payments shall be made on valuation of Work done based on an approved Schedule of Values to be submitted by the Contractor to the Owner through the Professional of the quantities aggregating the total of the Contract, prior to the first application for payment. The Schedule of Values shall, when approved by the Professional, be used as a basis for determining the percentage of the Contract sum comprising each Certificate of Payment.

Payments shall be made on the basis of 94% of the approved monthly schedule of Work performed as hereinbefore determined.

Thirty (30) days after this Contract shall have been fully performed, the Professional shall issue a certificate for any balance due subject to the provisions of Article 11 of the General Conditions.

ARTICLE 7: LIENS/PERFORMANCE BOND

Notwithstanding and in addition to the provisions relative to liens set forth in Paragraph 11.8 of the General Conditions of the Contract, the parties hereto have executed a Waiver of Liens / Stipulation Against Liens Agreement, and Contractor has purchased a payment bond which shall serve as a guarantee of payment for the work, services, labor, materials and/or equipment provided by any and all subcontractors. Contractor hereby specifically waives all lien rights of subcontractors, as that term is defined under the Pennsylvania Mechanics' Lien Law of 1963. Contractor hereby covenants, promises and agrees that no mechanics' or
materialism's lien or claim, or any other lien or claim, will be filed or maintained on the Property, or any grounds or curtilages appurtenant thereto, or any other structure or property owned by the Owner, either by Contractor or any subcontractor, for or on account of any work, labor or materials supplied by any subcontractor in the performance of the Contract, or under any supplemental contract for extra work, in the erection, construction or completion of the improvements to the Property.

ARTICLE 8: MISCELLANEOUS PROVISIONS

8.1 APPLICABLE LAW

The interpretation and construction of this Agreement shall be governed by the laws of the Commonwealth of Pennsylvania. In the event litigation arises out of this contract, the parties agree to submit any claim to the competent courts of Centre County, Pennsylvania.

8.2 SUCCESSORS AND ASSIGNS

This Agreement shall be binding on the successors and assigns of the parties hereto.

8.3 ASSIGNMENT

Neither the Owner nor the Contractor shall assign, sublet or in any manner transfer any right, duty, or obligation under this Agreement without prior written consent of the other party.

8.4 PROVISIONS REQUIRED BY PENNSYLVANIA LAW OR FEDERAL LAW

8.4.1 Provisions Deemed Inserted. Each and every provision required to be inserted in Contractor Agreements by the law of Pennsylvania, or the lawful regulations of any agency of the Commonwealth, and, if the Project involves the use of federal funds, by any law of the United States of America or the lawful regulations of any agency thereof applicable to this Agreement, are included in the Agreement by reference, and this Agreement shall be read, interpreted, and enforced as if such provisions were set forth therein in full.

8.4.2 Nondiscrimination. So long as this Agreement is in effect, the Contractor agrees to the terms of the Nondiscrimination Clause attached hereto as Exhibit "A."

8.4.3 Contractor Integrity Provisions and Disclosure of Financial Interest. So long as this Agreement is in effect, the Contractor agrees to the Contractor Integrity Provisions attached hereto as Exhibit "B."

8.4.4 Contractor Responsibility Provision. Included in and made a part of this Agreement is Exhibit "C," Contractor Responsibility Provision.

8.4.5 Tax Liability Provisions. Included in and made part of this Agreement is Exhibit "D," Tax Liability Provisions.

8.4.6 Trade Practice Act. Included in and made part of this Agreement is Exhibit "E," Trade Practices Act Contract Clause.

8.4.7 Steel Product Procurement Act. Included in and made part of this Agreement is Exhibit "F," Steel Products Procurement Act Contract Clause.

8.4.8 Public Works Contractor's Bond Law. Included in and made part of this Agreement is Exhibit "G," Public Works Contractor's Bond Law of 1967 Contract Clause.

8.4.9 Pennsylvania Prevailing Wage Act. Included in and made part of this Agreement is Exhibit "H," Pennsylvania Prevailing Wage Act Contract Clause.

8.4.10 Minority Business and Women Business Enterprise Participation. Included in and made part of this Agreement is Exhibit "I," Minority Business and Women Business Enterprise Participation.
6.5 RELEASE OF INFORMATION

The Contractor understands and agrees that the Owner may release to taxing authorities any and all information relating to the Work.

THIS AGREEMENT entered into as of the day and year written above.

THE PENNSYLVANIA STATE UNIVERSITY
OWNER

Title

ATTEST, Secretary

(Insert Contractor Name)
CONTRACTOR

Title

ATTEST, Secretary

03/2009

Form of Agreement DGS 1-C
DGS 1-C, Page 5 of 5
EXHIBIT A

NONDISCRIMINATION CLAUSE

During the term of this Contract, the Contractor agrees as follows:

1. Contractor shall not discriminate against any employee, applicant for employment, independent Contractor, or any other person because of race, color, religious creed, ancestry, national origin, age, sex or handicap. Contractor shall take affirmative action to insure that applicants are employed, and that employees or agents are treated during employment, without regard to their race, color, religious creed, ancestry, national origin, age, sex, or handicap. Such affirmative action shall include, but is not limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training. Contractor shall post in conspicuous places, available to employees, agents, applicants for employment, and other persons, a notice to be provided by the contracting agency setting forth the provision of this nondiscrimination clause.

2. Contractor shall, in advertisements or requests for employment placed by it or on its behalf, state all qualified applicants will receive consideration for employment without regard to race, color, religious creed, ancestry, national origin, age, sex, or handicap.

3. Contractor shall send each labor union or workers' representative with which it has a collective bargaining agreement or other Contract or understanding, a notice advising said labor union or workers' representative of its commitment to this nondiscrimination clause. Similar notice shall be sent to every other source of recruitment regularly utilized by Contractor.

4. It shall be no defense to a finding of noncompliance with this nondiscrimination clause that Contractor had delegated some of its employment practices to any union, training program, or other source of recruitment which prevents it from meeting its obligations. However, if the evidence indicates that the Contractor was not on notice of the third-party discrimination or made a good faith effort to correct it, such factor shall be considered in mitigation in determining appropriate sanctions.

5. Where the practice of a union or of any training program or other source of recruitment will result in the exclusion of minority group persons, so that Contractor will be unable to meet its obligations under this nondiscrimination clause, Contractor shall then employ and fill vacancies through other nondiscriminatory employment procedures.

6. Contractor shall comply with all state and federal laws prohibiting discrimination in hiring or employment opportunities. In the event of Contractor's noncompliance with the nondiscrimination clause of this Contract or with any such laws, this Contract may be terminated or suspended, in whole or in part, and Contractor may be declared temporarily ineligible for further Contracts, and other sanctions may be imposed and remedies invoked.

7. Contractor shall furnish all necessary employment documents and records to, and permit access to its books, records and accounts by the Contracting agency and the Office of Administration, Bureau of Minority and Women Business Opportunities (BMWBO) for purposes of investigation to ascertain compliance with the provisions of this clause. If Contractor does not possess documents or records reflecting the necessary information requested, it shall furnish such information on reporting forms supplied by the Contracting Agency and/or the Bureau of Minority and Women Business Opportunities (BMWBO).

8. Contractor shall actively recruit minority and women Subcontractors or Subcontractors with substantial minority representation among their employees.

9. Contractor shall include the provisions of this nondiscrimination clause in every Subcontract so that such provisions will be binding upon each Subcontractor.

10. Contractor's obligations under this clause are limited to the Contractor's facilities within Pennsylvania, or where the Contract is for purchase of goods manufactured outside of Pennsylvania, the facilities at which such goods are actually produced.

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Exhibit A
Page 1 of 1
EXHIBIT B

CONTRACTOR INTEGRITY PROVISIONS

1. Definitions.
   a. Confidential Information means information that is not public knowledge, or available to the public on request, disclosure of which would give an unfair, unethical, or illegal advantage to another desiring a Contract with the Commonwealth and/or Owner.
   b. Consent means written permission signed by a duly authorized officer or employee of the Commonwealth and/or Owner, provided that where the material facts have been disclosed, in writing, by prequalification, bid, proposal, or contractual terms, the Owner shall be deemed to have consented by virtue of execution of this Agreement.
   c. Contractor means the individual or entity that has entered into this Agreement with the Commonwealth and/or Owner, including directors, officers, partners, managers, key employees, and owners of more than a five percent (5%) interest.
   d. Financial interest means:
      (1) Ownership of more than a five percent (5%) interest in any business; or
      (2) Holding a position as an officer, director, trustee, partner, employee, or the like, or holding any position of management.
   e. Gratuity means any payment of more than nominal monetary value in the form of cash, travel, entertainment, gifts, meals, lodging, loans, subscriptions, advances, deposits of money, services, employment, or contracts of any kind.

2. The Contractor shall maintain the highest standards of integrity in the performance of this Agreement and shall take no action in violation of state or federal laws, regulations, or other requirements that govern contracting with the Owner.

3. The Contractor shall not disclose to others any confidential information gained by virtue of this Agreement.

4. The Contractor shall not, in connection with this or any other agreement with the Commonwealth and/or Owner, directly or indirectly, offer, confer, or agree to confer any pecuniary benefit on anyone as consideration for the decision, opinion, recommendation, vote, other exercise of discretion, or violation of a known legal duty by any officer or employee of the Commonwealth and/or Owner.

5. The Contractor shall not, in connection with this or any other Agreement with the Commonwealth and/or Owner, directly or indirectly, offer, give, or agree or promise to give to anyone any gratuity for the benefit of or at the direction or request of any officer or employee of the Commonwealth and/or Owner.

6. Except with the consent of the Commonwealth and/or Owner, neither the Contractor nor anyone in privity with the Contractor shall accept or agree to accept from, or give or agree to give to, any person, any gratuity from any person in connection with the performance of Work under this Agreement except as provided therein.

7. Except with the consent of the Commonwealth and/or Owner, the Contractor shall not have a financial interest in any other Contractor, Subcontractor, or supplier providing services, labor, or material on this project.

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Exhibit B
Page 1 of 2
8. The Contractor, upon being informed that any violation of these provisions has occurred or may occur, shall immediately notify the Commonwealth and/or Owner in writing.

9. The Contractor, by execution of this Agreement and by the submission of any bills or invoices for payment pursuant thereto, certifies and represents that the Contractor has not violated any of these provisions.

10. The Contractor, upon the inquiry or request of the Commonwealth and/or Owner, shall provide, or if appropriate, make promptly available for inspection or copying, any information of any type or form deemed relevant by the Commonwealth and/or Owner to the Contractor's integrity or responsibility, as those terms are defined by the Commonwealth's statutes, regulations, or management directives. Such information may include, but shall not be limited to, the Contractor's business or financial records, documents, or files of any type or form which refer to or concern this Agreement. Such information shall be retained by the Contractor for a period of three (3) years beyond the termination of the Contract unless otherwise provided by law.

11. For violation of any of the above provisions, the Commonwealth and/or Owner may terminate this and any other Agreement with the Contractor, claim liquidated damages in an amount equal to the value of anything received in breach of these provisions, claim damages for all expenses incurred in obtaining another Contractor to complete performance hereunder, and debar and suspend the Contractor from doing business with the Commonwealth and/or Owner. These rights and remedies are cumulative, and the use or nonuse of any one shall not prejudice the use of all or any other. These rights and remedies are in addition to those the Commonwealth and/or Owner may have under law, statute, regulation, or otherwise.
EXHIBIT C

CONTRACTOR RESPONSIBILITY PROVISION

1. Contractor certifies that it is not currently under suspension or debarment by the Commonwealth of Pennsylvania, any other state, or the federal government. Contractor also acknowledges that if it is currently under suspension or debarment, its bid, in most instances, will not be accepted or considered.

2. If Contractor enters into any subcontracts under this Contract with subcontractors who are currently suspended or debarred by the Commonwealth of Pennsylvania during the term of this Contract or any extensions or renewals thereof, the University shall have the right to require the Contractor to terminate such contracts.
EXHIBIT D

TAX LIABILITY PROVISIONS

1. The Contractor, by execution of the Contract:
   a. Certifies that the Contractor has no outstanding tax liability to the Commonwealth of Pennsylvania;
   b. Authorizes the Department of Revenue to release information related to its tax liability to the Department of General Services; and
   c. Authorizes the Commonwealth to offset any state and local tax liabilities of the Contractor or any of its subsidiaries, as well as any other amount due to the Commonwealth and/or Owner from the Contractor, against any payment due to the Contractor under a Contract with the Owner or the Commonwealth.

2. The certification of no outstanding tax liability is a material representation of fact upon which reliance is placed by the Commonwealth and/or Owner in entering into the Contract. If it is later determined that the Contractor knowingly rendered an erroneous certification, the Commonwealth and/or Owner may find the Contractor in default and terminate the Contract. Erroneous certification may also be grounds for the initiation of civil or criminal proceedings.
EXHIBIT E

TRADE PRACTICES ACT CONTRACT CLAUSE

1. In accordance with the Trade Practices Act of July 23, 1968, P.L. 688 (71 P.S. Section 773.101 et seq.), the Contractor cannot and shall not use or permit to be used in the Work any aluminum or steel products made in a foreign country which is listed below as a foreign country which discriminates against aluminum or steel products manufactured in Pennsylvania. The countries of Brazil, Spain, South Korea, Mexico, and Argentina have been found to discriminate against certain products manufactured in Pennsylvania. Therefore, the purchase or use of those countries' products, as listed below, is not permitted.

   a. Brazil: Welded carbon steel pipes and tubes; carbon steel wire rod; tool steel; certain stainless steel products including hot-rolled stainless steel bar, stainless steel wire rod and cold-formed stainless steel bars; prestressed concrete steel wire strand; hot-rolled carbon steel plate in coil; hot-rolled wire strand; hot-rolled carbon steel plate in coil; hot-rolled carbon steel sheet; and cold-rolled carbon steel sheet.

   b. Spain: Certain stainless steel products including stainless steel wire rod, hot-rolled stainless steel bars and cold-formed stainless steel bars; prestressed concrete steel wire strand; and certain steel products including hot-rolled steel plate, cold-rolled carbon steel plate, carbon steel structural shapes, galvanized carbon steel sheet, hot-rolled carbon steel bars and cold-formed carbon steel bars.

   c. South Korea: Welded carbon steel pipes and tubes; hot-rolled carbon steel plate; hot-rolled carbon steel sheet; and galvanized steel sheet.

   d. Mexico: Certain iron-metal construction castings including manhole covers, rings and frames, catch basin frames and grates, clean-out covers, grates, meter boxes, and valve boxes; galvanized carbon steel sheet; cold-rolled carbon steel sheet; carbon steel plate; carbon steel plate in coil; carbon steel plate cut to length; and small diameter carbon steel plate welded pipe.

   e. Argentina: Carbon steel wire rod and cold-rolled carbon steel sheet.

Penalties for violation of this paragraph may be found in the Trade Practices Act, which penalties include becoming ineligible for public works contracts for a period of three years.

NOTE: This provision in no way relieves the Contractor of responsibility to comply with those provisions of an invitation to bid which prohibits the use of foreign-made steel and cast-iron products.
1. In the performance of any Contract awarded pursuant to this Invitation to Bid, the Contractor, Subcontractors, materialmen, or suppliers shall use only steel products, rolled, formed, shaped, drawn, extruded, forged, cast, fabricated, or otherwise similarly, processed, or processed by a combination of two or more of such operations, from steel made in the United States by the open hearth, basic oxygen, electric furnace, Bessemer or other steel-making process. Steel products include not only cast-iron products but also machinery and equipment listed in United States Department of Commerce Standard Industrial Classifications 25 (furniture and fixtures), 35 (machinery, except electrical) and 37 (transportation equipment) and made of, fabricated from, or containing steel components. If a product contains both foreign and United States steel, it shall be determined to be a United States steel product only if at least 75 percent of the cost of the articles, materials, and supplies have been mined, produced, or manufactured, as the case may be, in the United States. Transportation equipment shall be determined to be a United States steel product only if it complies with Section 165 of Public Law 97-424 (96 Stat. 2136).

2. When unidentified steel products are supplied under a Contract, before any payment will be made, the Contractor must provide documentation including, but not limited to, invoices, bills of lading, and mill certification that the steel was melted and manufactured in the United States. If a steel product is identifiable from its face, the Contractor must submit certification which satisfies the Owner that the Contractor has fully complied with this provision. The Owner shall not provide for or make any payments to any person who has not complied with the Act. Any such payments made to any person by the Owner which should not have been made as a result of the Act shall be recoverable directly from the Contractor, Subcontractor, manufacturer, or supplier who did not comply with the Act.

3. In addition to the withholding of payments, any person who willfully violates any of the provisions of the Act shall be prohibited from submitting any bids to the Owner for a period of five years from the date of the determination that a violation has occurred. In the event the person who violates the provisions of the Act is a Subcontractor, manufacturer, or supplier, such person shall be prohibited from performing any work or supplying any materials to the Owner for a period of five years from the date of the determination that a violation has occurred.

4. The Contractor shall include the provisions of the Steel Products Procurement Act in every subcontract and supply Contract so that the provisions of the Act shall be binding upon each Subcontractor and supplier.
EXHIBIT G
PUBLIC WORKS CONTRACTOR'S BOND LAW OF 1967 CONTRACT CLAUSE

1. Prior to the award of any Contract, the Contractor to be awarded must furnish the following bonds which shall become binding upon the award of the Contract to the Contractor.

a. A performance bond at 100 percent of the Contract Amount, conditioned upon the faithful performance of the Contract in accordance with the plans, specifications, and conditions of the Contract. Such bond shall be solely for the protection of the University.

b. A payment bond at 100 percent of the Contract Amount. Such bond shall be solely for the protection of claimants supplying labor or materials to the Prime Contractor to whom the Contract was awarded, or to any of its Subcontractors, in the prosecution of the Work provided for in such Contract and shall be conditioned for the prompt payment of all such materials furnished or labor supplied or performed in the prosecution of the Work. "Labor or materials" includes public utility services and reasonable rentals of equipment, but only for the periods when the equipment rented is actually used at the site.
EXHIBIT H

Pennsylvania Prevailing Wage Act Contract Clause

1. The Contract with the awarded Contractor is subject to the provisions, duties, obligations, remedies, and penalties of the Pennsylvania Prevailing Wage Act, 43 P.S. Section 165-1 et seq., which is incorporated herein by reference as if fully set forth herein. The general prevailing minimum wage rates as determined by the Secretary of Labor and Industry shall be paid for each craft or classification of all workmen needed to perform this Contract during the term hereof for the locality in which the Work is to be performed.
EXHIBIT I

MINORITY BUSINESS AND WOMEN BUSINESS ENTERPRISE PARTICIPATION

1. Participation Level – MBE and WBE

a. Pursuant to the provisions of Executive Order No. 2004-6, the Department of General Services (DGS) has established minimum participation levels (MPLs) for utilization of Minority Business Enterprise (MBE) and Women Business Enterprise (WBE) subcontractors and suppliers for this project. A bidder’s MBE participation level is calculated by adding all dollar commitments to DGS-certified MBES and dividing that total amount by the total contract bid price. The bidder participation level for WBEs is similarly calculated by adding all dollar commitments to DGS-certified WBEs and dividing that total amount by the total contract bid price. Only DGS-certified MBES and WBEs may be used to achieve these MPLs. The MPLs are set forth in the Notice to Bidders in the following form:

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<thead>
<tr>
<th>Project No. D.G.S.</th>
<th>MBE</th>
<th>WBE</th>
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<tbody>
<tr>
<td>1. Hazardous Building Materials Abatement</td>
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<td>2. Building Demolition</td>
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<td>3. General Trades</td>
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<td>4. Fire Protection</td>
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<td>8. Telecommunications</td>
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<tr>
<td>9. Landscaping</td>
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</tbody>
</table>

b. Included in this invitation for bids is Form GSMWBE-16 (Form 16) which is comprised of two parts:

1. Certification (Form 16A).
2. Record of MBE/WBE Solicitations and Commitments (Form 16B)

**FORM 16A – CERTIFICATION MUST BE COMPLETED AND SIGNED BY EACH BIDDER AND SUBMITTED WITH ITS BID. FAILURE TO COMPLETE, SIGN AND SUBMIT THIS FORM WITH THE BID SHALL RESULT IN REJECTION OF THE BID.**

Form 16A requires bidders to respond to the MPLs in one of three ways:

1. A bidder can commit to meet both MPLs. If the bidder commits to meet both MPLs, no documentation in regard to MBE/WBE solicitations and commitments must be submitted with the bid.

2. A bidder can commit to meet participation levels lower than the MPLs, but must provide evidence by way of Form 16B – Record of MBE/WBE Solicitations And Commitments, and documentation (copies of MBE/WBE quotes) that it solicited a minimum of 5 MBE contractors and 5 WBE subcontractors within the Work Area (defined below) and 5 MBE suppliers and 5 WBE suppliers.

3. A bidder can commit to meet participation levels lower than the MPLs and can indicate that it did not solicit 5 MBE subcontractors, 5 WBE subcontractors, 5 MBE suppliers and 5 WBE suppliers but must provide a satisfactory written reason(s) for not soliciting the minimum number of MBEs and WBEs.
For item #1 above, a bidder must commit to meet both the MBE and WBE MPLs for the project. Bidders are encouraged to make these commitments. A bidder who commits to meet both the MBE and WBE MPLs only needs to check box 1, check the "yes" box for both MBEs and WBEs, sign the Certification form and submit it with its bid. The bidder is not required to:

(a) Complete the remaining portions of Form 16A - Certification;
(b) Complete Form 16B - Record of Solicitations and Commitments; or
(c) Submit any MBE/WBE solicitation/commitment documentation with its bid documents.

If the bidder is selected for award, the bidder will be required to submit detailed information including but not limited to any contracts or letters of intent documenting the bidder's commitment to the MPLs within ten (10) calendar days after notice of award from DGS.

For item #2 above, a bidder who does not, in its bid documents, commit to meet the MPLs but who has solicited a minimum of 5 MBEs and 5 WBEs for subcontracting and 5 MBEs and 5 WBEs for supplies, must:

(a) Complete and sign Form 16A – Certification;
(b) Complete Form 16B – Record of MBE/WBE Solicitations and Commitments; and
(c) Submit the completed Certification (Form 16A), the Record of MBE/WBE Solicitations and Commitments (Form 16B), copies of the MBE/WBE quotes that it received, and other applicable documentation concurrently with its bid.

Bidders must include information on the Record of MBE/WBE Solicitations And Commitments (Form 16B) identifying all MBEs and WBEs solicited, all MBE and WBE quotes received (solicited and unsolicited) and all MBEs and WBEs to which it has made commitments.

For item #3 above, a bidder who does not, in its bid documents, commit to the MPLs and who has not solicited 5 MBEs and 5 WBEs for subcontracting and 5 MBEs and 5 WBEs for supplies, must:

(a) Include in its bid documents the reason(s) that it did not solicit a minimum of 5 MBEs and 5 WBEs for subcontracting and 5 MBEs and 5 WBEs for supplies.
(b) Complete and sign Form 16A - Certification;
(c) Complete Form 16B - Record of MBE/WBE Solicitations and Commitments; and
(d) Submit the completed Certification (Form 16A), the Record of MBE/WBE Solicitation And Commitments (Form 16B), copies of MBE/WBE quotes that it received, and other applicable documentation concurrently with its bid.

Bidders must include information on Form 16B - Record of MBE/WBE Solicitations And Commitments identifying all MBEs and WBEs solicited, all MBE and WBE quotes received (solicited and unsolicited) and all MBEs and WBEs to which it has made commitments.
c. MBE/WBE subcontractors and manufacturers will be credited toward the MPLs at 100 percent of the total dollar value of the subcontract/supply contract. Stocking suppliers also are credited at 100 percent. Non-stocking suppliers, which are commonly and ordinarily the custom in the industry and a part of the industry's trade practice, also are credited at 100 percent of the total dollar value of the supply contract; non-stocking suppliers, which are not commonly and ordinarily the custom in the industry nor a part of the industry's trade practice, are not credited.

d. If the prime bidder is an MBE/WBE firm, DGS will not credit the value of the prime bidder's contract toward meeting the contract MPLs. All prime bidders (including MBE/WBE prime bidders) are expected to comply with these instructions to Bidders.

e. MBE/WBE subcontractors must perform at least seventy-five percent (75%) of the cost of the subcontract, not including cost of materials, with their own employees to be counted toward the MPLs.

f. A firm that is both an MBE and a WBE will receive credit toward the MPLs as either an MBE or WBE - not in both categories. Bidders must indicate on the Form 16B - Record of Solicitations and Commitments whether the firm is being listed as either an MBE or a WBE. If the bidder does not indicate whether it is using the firm as an MBE or a WBE, and that firm is certified as both an MBE and WBE, BMWBO shall credit the firm as either an MBE or a WBE.

2. Responsiveness

a. A bidder who commits in its bid documents to meet the MPLs in Form 16A - Certification, signs the Certification, and submits the Certification with its bid shall be presumed to be responsive. The bidder will be required to provide detailed information including but not limited to copies of quotes and any contractors or letters of intent documenting the bidder's commitment to the MPLs within ten (10) calendar days of a DGS request. Failure to provide the documentation, satisfactory to the Department, detailing commitments made to MBEs and WBEs within ten calendar days after notice of award from DGS shall result in rejection of the bid as non-responsive and the bidder's bid security shall be forfeited to DGS as liquidated damages for the bid default.

b. A bidder who does not commit in its bid documents to meet the MPLs must submit a completed Form 16A and 16B with its bid and must submit copies of all quotes (solicited and unsolicited) received from MBEs and WBEs. The bidder must comply with the following requirements in order to be considered responsive:

(1) **Minimum Solicitation Requirement.** Except as provided in subsections (4) and (5) below, where the amount bid exceeds $50,000 and the bidder does not commit to meet the MPLs, the bidder must solicit proposals from a minimum of 5 Department-certified MBE Subcontractors, 5 Department-certified WBE Subcontractors, 5 Department-certified MBE Suppliers, and 5 Department-certified WBE Suppliers. For clarity, unless the bidder commits to meeting the MPL for MBEs, the Bidder must solicit a minimum of 5 MBE Subcontractors and 5 MBE Suppliers. Similarly, unless the bidder commits to meeting the MPL for WBEs, the bidder must solicit a minimum of 5 WBE Subcontractors and 5 WBE Suppliers.
(2) **Work Area.** For subcontractors, solicitations must be made in the Work Area, which for the purposes of the Department’s MBE/WBE Policy is defined as the county in which the work is to be performed, adjoining counties, and any other county within a 50-mile radius of the job site. For subcontractors, except as provided in part (iv) below, if fewer than five eligible, Department-certified MBEs or five eligible, Department-certified WBEs exist within the Work Area, the bidder shall solicit from each category the maximum possible number of certified entities within the Work Area and solicit the remaining required number of certified entities outside of the Work Area.

(3) **Timely Solicitations.** The bidder must initiate all MBE/WBE solicitations no later than five (5) business days prior to the scheduled bid opening date.

(4) **Exemption of Minimum Solicitation Requirement for Subcontracting.** A bidder who will perform the contract work with its own forces is exempt from the minimum solicitation requirements for subcontractors only. If the bidder will perform the work with its own forces, it must provide an explanation on the Form 16A under statement 3.

(5) **Exemption of Minimum Solicitation Requirement for Supplies.** A bidder who will not need to procure supplies from any supplier or other outside resource is exempt from the minimum solicitation requirements for suppliers only. If the bidder will obtain no supplies from any resources outside of its own company, it must provide an explanation on the Form 16A under statement 3.

(6) **Written Explanations.** A bidder who does not commit to meet both MPLs must include a written explanation of its failure to commit to both MPLs on Form 16A under statement 2 or 3. This explanation must demonstrate that the bidder has not engaged in discriminatory practices. A bidder who does not meet the minimum solicitation requirement, including the exceptions identified in subsections (4) and (5) above, must provide a written explanation of its failure to do so on Form 16A under statement 3.

(7) **Solicitations.** Mailings intended to provide notice of a contractor's interest in bidding a construction contract to large numbers of MBEs and WBEs will not be deemed solicitations, but rather will be treated as informational notification only. A bidder should only solicit MBE/WBE subcontractors, manufacturers or suppliers whose work, material, or supplies are within the project scope and are related to project line items or portions thereof. Limited numbers of, or nonexistent, MBEs or WBEs in a geographic area, by itself, is not a reason for failing to solicit subcontractors, manufacturers or suppliers. Bidders must indicate whether minority or women businesses were solicited for each type of work the bidder expects to subcontract for and for all materials which the bidder expects to procure and, if not, the reason(s) solicitations were not made. The bidder must submit with its bid an example of its request for quotation issued to MBE and WBE contractors and suppliers.

(8) **DGS Certification.** BMWBO will credit only DGS-certified MBEs or WBEs toward a bidder's MPLs.

(9) **Commitments.** Bidders must indicate the reason why it has not committed to an MBE or WBE for a type of subcontract work or for certain supplies in any area where a quote was received from an MBE or WBE. Where the bidder receives no quotations and makes no commitments to MBEs or WBEs, the bidder must specify on Form 16B - Record of MBE/WBE Solicitations And Commitments that no quotes were received. If there is another reason why no commitments were made, then provide this reason. If the bidder fails to use a quote from an MBE or WBE because the bidder feels the quote was not competitive, the bidder must submit a copy of the lower or more competitive quote(s).
c. Failure to properly complete and submit Form 16A - Certification, and Form 16B - Record of MBE/WBE Solicitations And Commitments, and the required documentation with the bid shall result in the rejection of the bid. Failure to comply with the requirements in (1) through (3) of subparagraph 2.b. above shall also result in rejection of the bid as not responsive. If there is a technical deficiency in the information submitted on the Form, or if some or all of the required documentation is not submitted with the bid, or if the Department requests an explanation for the bidder's failure to comply with subparagraph 2.b.(3), then the Department, in its sole discretion, may notify the bidder by facsimile transmission or by express mail that the bidder has two (2) business days from the date of receipt of the notification to correct the deficiency. If the deficiency is not corrected within the two (2)-business day period, the bid will be rejected as nonresponsive. The two (2)-business day period is provided at the Department's discretion. The bidder is expected and required to make the necessary efforts regarding MBE and WBE subcontractors and suppliers five (5) business days prior to submission of the bid documents. A bidder who has not committed to meet the MPLs shall not be given the opportunity during the two (2)-business day period to solicit potential MBE/WBE subcontractors and suppliers. If a bidder fails to respond with the requested documentation within the two (2)-business day period, the Department may charge the difference between the nonresponsive bidder's bid price and the next responsive bidder's bid price against the nonresponsive bidder's bid security. Even if the Form 16A - Certification and Form 16B - Record of MBE/WBE Solicitations And Commitments are submitted and the bidder provides the documentation requested by DGS to establish its solicitations and commitments, DGS may also reject the bid if it determines that the bidder has discriminated against MBEs and/or WBEs in its solicitations and commitments to subcontractors or suppliers for the project.

d. Upon notice from the Department of the need to remedy any deficiency in the MBE/WBE submission requirements, the bidder should fully review the requirements as well as its submission and the subsequently provided information to ensure that the submission and the subsequently provided information fully comply with the requirements section A.31 and Form 16. The Department of General Services disclaims any and all responsibility for notifying the bidder of all deficiencies.

e. If a bidder is determined to be responsive, it does not mean that the bidder will be awarded the contract.

3. Responsibility

a. A bidder who does not commit to meet the MPLs for MBEs or WBEs shall meet the following standards for review:

(1) The bidder was not motivated by considerations of race or gender in failing to commit to the MPLs. If the bidder receives a solicited or unsolicited quote and does not commit to all or any portion of the quote, the bidder must provide a written explanation on Form 16A why the quote was not used, or why only a portion of the quote was used. The bidder must also furnish a copy of any competitive quote(s).

(2) The bidder must show that minority and women businesses were not treated less favorably than other businesses in the contract solicitation and commitment process.

(3) The bidder's solicitation and commitment decisions were not based upon policies, which discriminate against MBEs or WBEs.
b. Commitments to MBE and WBE firms made prior to contract award must be maintained throughout the term of any resulting contract, unless BMWBO has given prior written approval to a change in commitment to these firms.

c. If DGS selects a lower base bid, DGS may reduce the MBE/WBE commitments accordingly to reflect the reduction in the contract amount or changes in the contract scope. However, the MBE/WBE commitments remain intact if the deleted work does not affect the commitments.

4. Access to Information

BMWBO and the Office of the Inspector General may obtain documents and information that may be required to ascertain bidder or contractor responsibility from any bidder, contractor, subcontractor, supplier or manufacturer. If the bidder fails to provide requested information, the Department may declare the bidder not responsible. Information the Department obtains during a review of a firm’s solicitation and commitment process will be maintained on a confidential basis, to the extent permitted by law.

5. MBE/WBE Certification

a. BMWBO will not credit a bidder for MBE/WBE manufacturers, subcontractors or suppliers that are not DGS-certified as MBEs or WBEs. All firms listed in the bid documents – including out-of-state firms – must be DGS-certified as an MBE or WBE to receive credit.

b. DGS certification of an entity as an MBE or WBE means only that the applicant for certification has submitted information that qualifies it as an MBE or WBE in terms of its ownership and control. DGS certification does not imply, and no bidder shall infer, that the Department has in any way investigated or approved the entity’s competence to perform work.

c. Under the Act of December 21, 1994, No. 230, P.L. 210, 18 Pa. C.S.A. § 4017.2, a person commits a felony of the third degree, if, in the course of business, he or she engages in deception relating to MBE/WBE certification.

6. Bid as Part of the Contract

The bid of the successful bidder, including the completed MBE/WBE Solicitation/Commitment Sheet and accompanying documents regarding solicitation and commitments to MBEs and WBEs, becomes part of the contract.

7. Resources

a. The Bureau of Minority and Women Business Opportunities (BMWBO) is available for technical assistance to all bidders submitting proposals for this contract. A listing of Department-certified MBEs and WBEs is incorporated in the contract documents. Department certification of an entity as an MBE/WBE means only that the applicant for certification has submitted information that qualifies it as an MBE/WBE in terms of its ownership and control. It does not imply, and no bidder shall infer, that the Department has in any way investigated or approved the entity’s competence to perform work.

b. Contact the Bureau of Minority and Women Business Opportunities at 717/787-7380. Address correspondence to:

Bureau of Minority and Women Business Opportunities
611 North Office Building
Harrisburg, Pennsylvania 17125
MBE/WBE SUBCONTRACTOR AND SUPPLIER CERTIFICATION, SOLICITATION AND COMMITMENT FORM

This form, GSMWBE-16 (Form 16), is comprised of two parts: 16A - Certification and 16B - Record of MBE/WBE Solicitations and Commitments. Instructions on how to complete both parts of this form are provided at the end of this document.

FORM 16A – CERTIFICATION

This Form 16A must be completed and signed by each bidder and submitted with its bid.

Bidder name: ____________________________

Project #: ________________________________

☐ 1. We commit to meet the MPLs for the project as stated in the Notice to Bidders for:

   MBEs  Yes ___  No ___
   WBEs  Yes ___  No ___

If the answer for both MBEs and WBEs is “Yes” GO DIRECTLY TO THE SIGNATURE LINES AT THE END OF THIS CERTIFICATION. You do not need to complete the remainder of this form and you do not need to complete Form 16B.

If either answer is “No” you must check and complete either statement 2 or 3 below, sign this form and complete Form 16B.

☐ 2. We do not commit to meet both MPLs as stated in the Notice to Bidders. However, we did meet the minimum solicitation requirements (5 MBE subcontractors and 5 WBE subcontractors from the "Work Area" as defined in the Instructions to Bidders Section A.31 and 5 MBE suppliers and 5 WBE suppliers) and we commit to the following participation levels:

   MBEs ___ %  WBEs ___ %

☐ We have included below an explanation of our failure to commit to both MPLs. (Attach additional sheets as necessary.)

   MBE: ____________________________
   WBE: ____________________________

☐ We have completed and included with our bid the Form 16B - Record of MBE/WBE Solicitations and Commitments.

☐ We included with our bid all additional documentation as required in the Form 16 - Instructions and the Instructions to Bidders Section A.31.

☐ We conducted all initial MBE/WBE solicitations at least five (5) business days in advance of the bid opening day.

Failure to check all boxes under this statement 2, to indicate the MBE/WBE participation levels, and to provide a satisfactory explanation shall result in the rejection of your bid as not responsive.
3. We do not commit to meet both MPLs as stated in the Notice to Bidders and we did not meet the minimum solicitation requirements (5 MBE subcontractors and 5 WBE subcontractors from the "Work Area" as defined in the Instructions to Bidders Section A.31 and 5 MBE suppliers and 5 WBE suppliers); however, we do commit to the following participation levels:

MBEs ___ %  WBEs ___ %

☐ We have included below an explanation of our failure to commit to both MPLs. (Attach additional sheets as necessary.)

MBE: __________________________________________

WBE: __________________________________________

☐ We have included below an explanation for our failure to comply with the minimum solicitation requirements. For example, if you do not intend to use any subcontractors you may state that fact as your reason for noncompliance. Complete as many as are appropriate. (Attach additional sheets as necessary.)

MBE subcontractors __________________________________________

WBE subcontractors __________________________________________

MBE suppliers __________________________________________

WBE suppliers __________________________________________

☐ To the extent that we have solicited MBEs and WBEs, we have completed and included with our bid the Form 16B - Record of MBE/WBE Solicitations and Commitments.

☐ We have included with our bid all additional documentation as required in the Form 16 - Instructions and the Instructions to Bidders Section A.31.

☐ We conducted all initial MBE/WBE solicitations at least five (5) business days in advance of the bid opening day.

Failure to check all boxes under this statement 3, to indicate the MBE/WBE participation levels, and to provide satisfactory explanations shall result in the rejection of your bid as not responsive.

Signature Certification

I certify that the information on this form is true and correct to the best of my knowledge and that I am authorized to represent the above-named Bidder in connection with this certification.

Signature: __________________________________________
Name (print or type): __________________________________________
Title: __________________________________________
FORM 16B - RECORD OF MBE/WBE SOLICITATIONS AND COMMITMENTS

<table>
<thead>
<tr>
<th>Company Name:</th>
<th>Contract Number &amp; Point:</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIN No.:</td>
<td></td>
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<tr>
<td>Address:</td>
<td></td>
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<tr>
<td>Telephone:</td>
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<tr>
<td>FAX No.:</td>
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<tr>
<td>E-Mail Address:</td>
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<tr>
<td>Contact Person:</td>
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<tr>
<td>Project Name:</td>
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<td>County:</td>
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<tr>
<td>Bid Amt. (Base Bid #1):</td>
<td>$</td>
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</tbody>
</table>

Note to Bidders:
In completing this form, the Bidder must comply with the Form 16 - Instructions and the Instruction for Bidders Section A.31. The following is provided for informational purposes only.

1. If you commit in your bid to meet the MPLs for both MBEs and WBEs you do not need to complete this Form 16B.
2. If you do not commit in your bid to meet both MPLs you must complete this Form 16B and submit all additional documentation as required by the Instruction to Bidders Section A.31 and as described in the Form 16 - Instructions. Failure to do so will be sufficient cause for rejection of the bid as NOT RESPONSIVE.
3. In completing Form 16B, the Bidder shall (see Form 16 - Instructions and Instructions to Bidders Section A.31 for complete detail):
   a. solicit a minimum of 5 Subcontractors-MBE, 5 Subcontractors-WBE, 5 Suppliers-MBE and 5 Suppliers-WBE;
   b. initiate all solicitation at least five (5) business days prior to the bid opening date;
   c. solicit MBE and WBE subcontractors within the Work Area, as defined in the Instructions to Bidders Section A.31, and
   d. record on Form 16B information pertaining to all solicitations, quotes (solicited and unsolicited) and commitments from MBE and WBE firms.
4. By submitting this form, the Bidder certifies that it has solicited the MBE and WBE firms for all services for which it intends to enter into a subcontract and for all supplies for which it intends to purchase within the Contract scope of work.
<table>
<thead>
<tr>
<th>Company Name, Address, Zip Code, County Tel. No. with Area Code Contact Person's Name</th>
<th>DGS-certified MBE?</th>
<th>Type of Work to be Performed and/or Material to be Supplied</th>
<th>Total Dollar Amount of Quote Received</th>
<th>Total Commitment Dollar Amount</th>
</tr>
</thead>
</table>
FORM 16 - INSTRUCTIONS

1.0 Purpose
The purpose of Form GSMWBE-16 (Form 16) is to secure documentation that ensures that the Bidder has not discriminated against MBE and WBE subcontractors and suppliers in the Bidder’s solicitation of and commitments to subcontractors and suppliers. Form 16 is comprised of two parts: 16A – Certification and 16B – Record of MBE/WBE Solicitations and Commitments as well as these instructions. Before completing Form 16, the Department of General Services (Department) strongly encourages the Bidder to review the Instruction to Bidders Section A.31: Minority Business and Women Business Enterprise Participation for further instruction on completing Form 16 and consequences for providing incomplete or incorrect information.

2.0 Instructions for Form 16A – Certification
All Bidders must complete, sign and submit Form 16A – Certification (Form 16A) with their bids.

Instructions for Statement 1
Check box 1 and complete statement 1, if you commit to meet both MPLs for the project or if you commit to meet the MPL for either MBEs or WBEs.

A Bidder who commits to meet both the MPLs for MBEs and WBEs only needs to check the “yes” box for both MBEs and WBEs, and to have an authorized representative of the company sign the form. If the Bidder is selected for award, the Bidder will be required to submit detailed information including but not limited to copies of quotes and any contracts or letters of intent documenting the Bidder’s commitment to the MPLs within ten calendar days after notice of award from the Department. Failure to provide the documentation satisfactory to the Department, detailing commitments made to MBEs and WBEs within ten (10) calendar days after notice of award from the Department shall result in rejection of the bid as non-responsive and the Bidder’s bid security shall be forfeited to the Department as liquidated damages for the bid default.

A Bidder who commits to only one MPL is required to indicate which MPL, and to complete the remaining portions of the Form 16A and Form 16B in compliance with the instructions provided herein and the instructions to Bidders Section A.31.

Instructions for Statement 2
Check box 2 and complete statement 2 if you do not commit to meet both MPLs but you have complied with the minimum solicitation requirements: you have solicited proposals from a minimum of 5 MBEs and 5 WBEs for subcontracting from the “Work Area” as defined in the Instructions to Bidders Section A.31 and 5 MBEs and 5 WBE for supplies.

A Bidder who does not commit to meet both MPLs but who meets the minimum solicitation requirements must:

1. Indicate the MBE and WBE participation levels that it has committed to in its bid.
2. Indicate by checking the first check box that it has provided in the space provided an explanation of its failure to commit to both MPLs. If the Bidder provides its explanation on a separate page it must indicate so in the space provided.
3. Indicate by checking the second check box that it has completed Form 16B.
4. Indicate by checking the third check box that it has included with its bid the additional documentation as required in these instructions and the Instructions to Bidders Section A.31.
5. Indicate by checking the fourth check box that it has conducted all initial MBE/WBE solicitations at least five (5) business days in advance of the bid opening day.
6. Have an authorized representative of the company sign Form 16A.
Commonwealth of Pennsylvania
Department of General Services
GSNWBE-16 (R04)

Failure to properly complete and submit Forms 16A and 16B and to provide the additional documentation as required in the Instruction to Bidders Section A.31 with the bid shall result in the rejection of the bid.

**Instructions for Statement 3**

Complete statement 3 if you do not commit to meet both MPLs and you have not complied with the minimum solicitation requirements: you have not solicited proposals from a minimum of 5 MBEs and 5 WBEs for subcontracting from the "Work Area" as defined in the Instructions to Bidders Section A.31 and 5 MBEs and 5 WBE for supplies.

A Bidder who does not commit to both MPLs and who does not meet the minimum solicitation requirements must:

1. Indicate the MBE and WBE participation levels that it has committed to in its bid.
2. Indicate by checking the first check box that it has provided an explanation of its failure to commit to both MPLs. If the Bidder provides its explanation on a separate page it must indicate so in the space provided.
3. Indicate by checking the second check box that it has provided an explanation for not meeting the minimum solicitation requirements. If the Bidder provides its explanation on a separate page it must indicate so in the space provided.
4. Indicate by checking the third check box that it has completed Form 16B to the extent that it has solicited MBEs and WBEs and included it with its bid.
5. Indicate by checking the fourth check box that it has included with its bid the additional documentation as required in these instructions and the Instructions to Bidders Section A.31.
6. Indicate by checking the fifth check box that it has conducted all initial MBE/WBE solicitations at least five (5) business days in advance of the bid opening day.
7. Have an authorized representative of the company sign Form 16A.

Failure to properly complete and submit Forms 16A and 16B and to provide the additional documentation required in the Instruction to Bidders Section A.31 with the bid shall result in the rejection of the bid.

**3.0 Instructions for Form 16B - Record of MBE/WBE Solicitations and Commitments**

A Bidder who commits in its bid documents to meet the MPLs does not need to complete Form 16B. Form 16B must be completed by the Bidder who does not commit to meet both MPLs as set forth in the Notice to Bidders. A Bidder completing Form 16B must solicit and commit to Department certified MBEs and WBEs only. Firms certified by any other entity will not be recognized for purposes of compliance with these instructions and the invitation for bids. The Department's searchable database of certified MBE/WBE firms appears on the Department's website: [http://www.dgsapp.state.pa.us/imaginepa/bcabd/vendor_search.asp?bcabdRNavra46BCZC=](http://www.dgsapp.state.pa.us/imaginepa/bcabd/vendor_search.asp?bcabdRNavra46BCZC=)

**Instructions for Block 1**

Provide your company name, federal employer identification number, address, telephone number, fax number, e-mail address and contact person. The e-mail address should be for the person within your organization who handles contract compliance or EEO-related issues.

**Instructions for Block 2**

Provide the Department's contract number, project name, county in which project is located, and total amount of the bid. If more than one base bid is submitted, provide the total bid amount for Base Bid #1.

**Instructions for Blocks 3 - 7**

3. Enter the subcontractor or supplier's company name exactly as it appears on the Department's website list of certified MBEs/WBEs. Do not use a D/B/A (Doing Business As) name. List the address, zip code, county, telephone number with area code, and contact person's name.
4. Indicate whether the firm is a Department-certified MBE or WBE. If the firm is both a Department-certified MBE and a Department-certified WBE, the Bidder will receive credit for the firm as either an MBE or a WBE, at the Bidder’s determination. The Department shall count a firm toward only one category.

5. Briefly describe the specific type of work to be performed and/or materials to be supplied by the listed Department-certified MBE or WBE. In order to count towards reaching the MPLs, the Bidder must solicit Department-certified MBEs/WBEs for the goods and services for which they are certified. For example, if an MBE/WBE is Department-certified for electrical supplies and the Bidder lists plumbing supplies, the Bidder will not receive credit for that firm. Geographical location may not be used as a reason for limiting MBE/WBE solicitations.

6. Enter the total dollar ($) amount of any (solicited and non-solicited) quote received. If the quote was received in the form of unit prices or hourly rates, a total dollar amount must still be provided. If the solicited subcontractor did not respond to the Bidder, the Bidder must indicate “No Response.” Copies of all MBE/WBE quotes (solicited and unsolicited) must be submitted with the bid. In addition, the bidder must submit with its bid an example of its request for quotation issued to MBE and WBE contractors and suppliers.

7. Enter the total dollar ($) amount of the contractual commitment made to the listed MBE/WBE. If the Bidder does not commit to use the quote from a MBE/WBE because lower a priced quote was received, the Bidder must provide an explanation with its bid and submit a copy of the lower priced quote. On partial commitments, the Bidder must provide an explanation with its bid why it made only a partial commitment and must submit a copy of the lower priced quote.

4.0 The Bureau of Minority and Women Business Opportunities

The Bureau of Minority and Women Business Opportunities (BMWBO) is available for technical assistance to all Bidders submitting proposals for this contract. A listing of Department-certified MBEs and WBEs is incorporated in the contract documents. Department certification of an entity as an MBE/WBE means only that the applicant for certification has submitted information that qualifies it as an MBE/WBE in terms of its ownership and control. It does not imply, and no Bidder shall infer, that the Department has in any way investigated or approved the entity’s competence to perform work. Please direct your question to:

Bureau of Minority and Women Business Opportunities
502 North Office Building
Harrisburg, Pennsylvania 17125
717-787-7380
GENERAL CONDITIONS OF THE CONTRACT

THE PENNSYLVANIA STATE UNIVERSITY
SCHEDULE OF ARTICLES

ARTICLE 1 - GENERAL CONTRACT DEFINITIONS
ARTICLE 2 - CONTRACT DOCUMENTS
ARTICLE 3 - INSURANCE AND BONDS
ARTICLE 4 - GOVERNING LAWS
ARTICLE 5 - STANDARDS, SUBSTITUTIONS, AND SHOP DRAWINGS
ARTICLE 6 - KNOWLEDGE OF CONTRACT REQUIREMENTS
ARTICLE 7 - CONTRACT ADMINISTRATION
ARTICLE 8 - CONSTRUCTION
ARTICLE 9 - CHANGES IN THE WORK
ARTICLE 10 - CONTRACT COMPLETION TIME
ARTICLE 11 - PAYMENTS AND COMPLETION
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<td><strong>Article 5 - Standards, Substitutions, and Shop Drawings</strong></td>
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ARTICLE 1 - GENERAL CONTRACT DEFINITIONS

1.1 THE CONTRACT DOCUMENTS

The Contract Documents consist of the Form of Agreement 1-C or Form of Agreement DGS 1-C, hereinafter called the Agreement, General Conditions of the Contract, Drawings, Specifications, Addenda issued prior to receipt of bids, Form of Proposal, other documents listed in the Agreement, and those modifications to the Contract as follows:

1.1.1 Owner's written authorization to the Contractor for changes to the Work

1.1.2 Change Order

1.1.3 A written order for a minor change in the Work issued by the Professional

1.2 THE CONTRACT

The Contract Documents form the Contract for Construction. The Contract represents the entire and integrated agreement between the parties hereto and supersedes all prior negotiations, representations or agreements either written or oral.

The Contract may be amended only by those modifications described in Paragraph 1.1.

1.3 OWNER

The Owner is The Pennsylvania State University, a corporation created and existing under the laws of the Commonwealth of Pennsylvania, hereinafter called the Owner, and shall mean the Owner or the Owner's authorized representative.

1.4 PROFESSIONAL

The Professional is the person lawfully licensed to practice architecture or engineering, or the firm employed to provide architectural or engineering services. The term "Professional" shall mean the Professional or the Professional's authorized representative.

1.5 CONTRACTOR

The Contractor is the individual, corporation, company, partnership, firm, or other organization that has contracted to perform the Work under the Agreement with the Owner. The term "Contractor" shall mean the Contractor or the Contractor's authorized representative.

1.6 SUBCONTRACTOR

A Subcontractor is a person or organization who contracts under, or for the performance of part or all of, the Contract between the Owner and the Contractor. The subcontract may be direct with the Contractor or with another Subcontractor. The term "Subcontractor" shall mean the Subcontractor or the Subcontractor's authorized representative.

1.7 THE WORK

The term "Work" shall mean whatever is done by or required of the Contractor to perform and complete its duties under this Contract, including the following: construction of the whole or a designated part of the Project; furnishing of any required surety bonds and insurance; and the provision or furnishing of labor, supervision, services, materials, supplies, equipment, fixtures, appliances, facilities, tools, transportation, storage, power, permits and licenses required of the Contractor; fuel, heat, light, cooling and all other utilities as required by this Contract.
1.8 THE PROJECT

The term "Project" shall comprise the Work defined by the Contract Documents and may include Work by the Owner or other Separate Contractors, or the Professional.

1.9 THE DRAWINGS

The Drawings are the graphic portion of the Contract Documents generally consisting of plans, elevations, sections, details, diagrams and schedules of the Work.

1.10 THE SPECIFICATIONS/PROJECT MANUAL

The Specifications are the written portion of the Contract Documents generally outlining the requirements for materials, equipment, construction systems, methods, standards, workmanship and performance necessary to properly complete the Work.

The Project Manual is the document assembled consisting of all the written portions for the Work including the Specifications, bidding requirements, sample forms, General Conditions and Special Requirements.

1.11 DAY

Whenever the word "day" is used in the Contract Documents, it shall be interpreted to mean a calendar day unless otherwise noted.

1.12 THE CONTRACT SUM

The Contract Sum is the total compensation payable to the Contractor for performing the Work as specified in the Contract Documents or subsequently adjusted by modification to the Contract.

1.13 CLAIM

A Claim is a demand or assertion by one of the parties seeking, as a matter of right, adjustment or interpretation of Contract terms, payment of money, extension of time or other relief with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question between the Owner and Contractor arising out of or relating to the Contract. Claims must be made by written notice. The responsibility to substantiate Claims shall rest with the party making the Claim.

1.14 SCOPE OF WORK

All Work reasonably contemplated, required, implied or reasonably inferable by the Contract Documents, whether or not explicitly contained in the Contract Documents.

1.15 SUBSTANTIAL COMPLETION

"Substantial Completion" shall mean that stage in the progression of the Work when the Work is sufficiently complete in accordance with this Contract that the Owner can enjoy beneficial use or occupancy of the Work and can utilize the Work for its intended purpose.

ARTICLE 2 - CONTRACT DOCUMENTS

2.1 OWNERSHIP AND USE OF DOCUMENTS

All Drawings, Specifications and other documents of the Work furnished by the Professional are and shall remain the Professional's property. They are not to be used by the Contractor on other projects without written consent of the Owner and the Professional.
2.2 COPIES FURNISHED - DRAWINGS AND SPECIFICATIONS

The Professional will furnish to the Contractor, free of charge, three copies of Drawings and Specifications for the execution of the Work. The Drawings will be prints on paper, unmounted. Any additional copies of the Drawings and Specifications which the Contractor may desire will be furnished at the cost of reproduction and delivery.

2.3 DRAWINGS AND SPECIFICATIONS AT THE SITE

The Contractor shall maintain at the site one copy of all Drawings, Specifications, Addenda, approved Shop Drawings, Product Data, Samples and Contract Modifications, in good order and marked to record all changes made during construction.

2.4 AS-BUILT AND RECORD DRAWINGS

The Contractor shall, at the time of substantial completion of the Work, deliver to the Professional the complete set of as-built drawings. The Professional will, within 30 days after receipt from the Contractor, transcribe all changes recorded by the Contractor onto a full set of reproducible drawings, and CADD electronic media, compatible with the Owner's CADD system, which shall become the record drawings for the Project, and shall forward same to the Owner. A copy in CADD format compatible with the Owner's CADD system and a copy in .pdf format shall be forwarded to the Owner by the Professional. If Building Information Modeling is utilized on the project an additional alternate form of as-built/record drawings may be required to be submitted by both the Professional and Contractor.

2.5 INTERRELATIONSHIP AND INTENT OF DOCUMENTS

2.5.1 The intent of this Contract is to require complete, correct, and timely execution of the Work. Any Work that may be required, implied, or inferred by the Contract Documents, or any one or more of them, as necessary to produce the intended result shall be provided by the Contractor for the Contract Price.

2.5.2 This Contract is intended to be an integral whole and shall be interpreted as internally consistent. What is required by any one Contract Document shall be considered as required by the Contract.

2.5.3 When a word, term, or phrase is used in this Contract, it shall be interpreted or construed, first, as defined herein; second, if not defined, according to its generally accepted meaning in the construction industry; and third, if there is no generally accepted meaning in the construction industry, according to its common and customary usage.

2.5.4 The words "include," "includes," or "including," as used in this Contract, shall be deemed to be followed by the phrase, "without limitation."

2.5.5 The specification herein of any act, failure, refusal, omission, event, occurrence or condition as constituting a material breach of this Contract shall not imply that any other, nonspecified act, failure, refusal, omission, event, occurrence, or condition shall be deemed not to constitute a material breach of this Contract.

2.5.6 Words or terms used as nouns in this Contract shall be inclusive of their singular and plural forms, unless the context of their usage clearly requires a contrary meaning.

2.5.7 The Contractor shall have a continuing duty to read, carefully study and compare each of the Contract Documents, the Shop Drawings, and the Product Data and shall give written notice to the Owner of any inconsistency, ambiguity, error or omission which the Contractor may discover with respect to these documents before proceeding with the affected Work. The issuance, or the express or implied approval by the Owner or the Professional of the Contract Documents, Shop Drawings, or Product Data shall not relieve the Contractor of the continuing duties imposed hereby, nor shall any such approval be evidence of the Contractor's compliance with this Contract. The Owner has requested the Professional to only prepare documents for the Project, including the Drawings and Specifications for the Project, which are accurate, adequate, consistent, coordinate and sufficient for construction. HOWEVER, THE OWNER MAKES NO REPRESENTATION OR WARRANTY OF ANY NATURE WHATSOEVER TO THE CONTRACTOR CONCERNING

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SUCH DOCUMENTS. By the execution hereof, the Contractor acknowledges and represents that it has received, reviewed, and carefully examined such documents, has found them to be complete, accurate, adequate, consistent, coordinated and sufficient for construction, and that the Contractor has not, does not, and will not rely upon any representation or warranties by the Owner concerning such documents as no such representation or warranties have been or are hereby made.

2.5.8 Neither the organization of any of the Contract Documents into divisions, sections, paragraphs, articles, (or other categories), nor the organization or arrangement of the Design, shall control the Contractor in dividing the Work or in establishing the extent or scope of the Work to be performed by Subcontractors.

2.5.9 The interrelation of the Drawings, the Specifications and the schedules is as follows:

2.5.9.1 The Drawings establish the quantities, dimensions and details.

2.5.9.2 The Specifications determine the nature and installation of the various materials and equipment.

2.5.9.3 The schedules give the locations.

2.5.9.4 The Drawings and Specifications are complementary and what is required by one shall be as binding as if shown or mentioned in both.

2.5.9.5 Should the Drawings disagree with one another, or with the Specifications, the better quality or greater quantity of Work or materials shall be performed or furnished. Dimensions given on Drawings govern small scale Drawings.

Dimensions given on Drawings govern scale measurements, and large scale details govern small scale drawings. In case of discrepancy in the Dimensions, in the Drawings, in the schedules, or in the Specifications, the matter shall be promptly submitted to the Professional who will promptly make a determination, after advice and consent of the Owner, in writing.

2.5.9.6 The "Scope of the Work," usually placed in the front part of each Section of the Specifications, is intended to designate the scope and locations of all items of the Work included therein, either generally or specifically. It is not intended to limit the Scope of Work should plans, schedules or notes indicate an increased scope. Inadvertent omission of an item from its proper section of the Specifications and its inclusion in another section shall not relieve the Contractor of responsibilities for the item specified.

ARTICLE 3 - INSURANCES AND BONDS

3.1 CONTRACTOR'S LIABILITY INSURANCE

The Contractor shall purchase from and maintain with a company or companies lawfully authorized to do business in the Commonwealth of Pennsylvania such insurance as will protect the Contractor from Claims set forth below which may arise out of or result from the Contractor's operations under the Contract and for which the Contractor may be legally liable, whether such operations be by the Contractor or by a Subcontractor or by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable:

3.1.1 Claims under the Workers' Compensation Act including Employers' Liability.

3.1.2 Claims for damages because of bodily injury, personal injury, sickness or disease, or death of any person other than the Contractor's employees.

3.1.3 Claims for damages, other than to the Work itself, because of injury to or destruction of tangible property, including loss of use resulting therefrom.

3.1.4 Claims for damages because of bodily injury, or property damage arising out of ownership, maintenance or use of a motor vehicle.

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3.1.5 Claims involving contractual liability insurance applicable to the Contractor's obligations under Paragraph 14.2 Indemnification.

The insurance required above shall be written for not less than limits of liability specified in the Contract Documents. Coverages, whether written on an occurrence or claims-made basis, shall be maintained without interruption from date of commencement of the Work until date of final payment and termination of any coverage required to be maintained after final payment.

Before commencing the Work, the Contractor and any Subcontractor shall purchase and maintain at its own expense until final completion and acceptance of the Work, the following minimum insurance:

3.1.6 Workers' Compensation for statutory obligations imposed by workers' compensation or occupational disease laws. Employers' Liability insurance shall be provided with a limit of not less than $100,000 for each subcategory of coverage.

3.1.7 Comprehensive Automobile Liability insurance with limits of liability not less than:

Bodily Injury Liability

$1,000,000 Combined Single Limit

Property Damage Liability

3.1.8 Commercial General Liability Insurance including the Broad Form Endorsement. Such policies shall show The Pennsylvania State University as an "additional insured," and include coverage for premises and operations, products and completed operations and contractual liability for all operations required to complete the Work, including, if applicable, coverage for damage caused by explosion, collapse, or damage to underground utilities with limits of liability not less than:

PROJECTS UNDER $1,000,000

Bodily Injury Liability

$1,000,000 Combined Single Limit

Property Damage Liability

PROJECTS OVER $1,000,000

Bodily Injury Liability

$5,000,000 Combined Single Limit

Property Damage Liability

The products and completed operations liability insurance shall be provided for a period of not less than two years after completion of the Work.

3.1.9 Special Hazards - If there is a possibility of special hazards existing in the Work contemplated, such hazards shall be covered by endorsement to the policy or policies.

Certificates of Insurance acceptable to the Owner shall be filed with the Owner prior to commencement of the Work. These Certificates and the insurance policies required by this paragraph shall contain a provision that coverages afforded under the policies will not be cancelled or allowed to expire until at least 30 days prior written notice has been given to the Owner. If any of the foregoing insurance coverages are required to remain in force after final payment and are reasonably available, an additional certificate evidencing continuation of such coverage shall be submitted with the final Application for Payment as required by Paragraph 11.8. Information concerning reduction in coverage shall be furnished by the Contractor with reasonable promptness in accordance with the Contractor's information and belief.

3.2 OWNER'S LIABILITY INSURANCE

The Owner shall be responsible for purchasing and maintaining the Owner's usual liability insurance. Optionally, the Owner may purchase and maintain other insurance for protection against Claims which may arise from operations under the Contract. The Contractor shall not be responsible for purchasing and maintaining this optional Owner's liability insurance unless specifically required by the Contract Documents.

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3.3 PROPERTY INSURANCE

Unless otherwise provided, the Owner shall purchase and maintain, in a company or companies lawfully authorized to do business in the Commonwealth of Pennsylvania, property insurance in the amount of the initial Contract Sum as well as subsequent modifications thereto for the entire Work at the site on a replacement cost basis subject to reasonable deductibles. Such property insurance shall be maintained, unless otherwise provided in the Contract Documents or otherwise agreed in writing by all persons and entities who are beneficiaries of such insurance, until final payment has been made as provided in Paragraph 11.8 or until no person or entity other than the Owner has an insurable interest in the property required by this Paragraph 3.3 to be covered whichever is earlier. This insurance shall include interests of the Owner, the Contractor, Subcontractors and Sub-subcontractors in the Work.

3.3.1 Property insurance shall be on an all-risk policy form and shall insure against the perils of fire and extended coverage and physical loss or damage including, without duplication of coverage, vandalism, malicious mischief, collapse, temporary buildings and debris removal including demolition occasioned by enforcement of any applicable legal requirements, and shall cover reasonable compensation for the Professional’s services and expenses required as a result of such insured loss. Coverage for other perils shall not be required unless otherwise provided in the Contract Documents.

3.3.2 If the Owner does not intend to purchase such property insurance required by the Contract and with all of the coverages in the amount described above, the Owner shall so inform the Contractor in writing prior to commencement of the Work. The Contractor may then obtain insurance which will protect the interests of the Contractor, Subcontractors and Sub-subcontractors in the Work, and by appropriate Change Order the cost thereof shall be charged to the Owner. If the Contractor is damaged by the failure or neglect of the Owner to purchase or maintain insurance as described above, without so notifying the Contractor, then the Owner shall bear all reasonable costs properly attributable thereto.

3.3.3 The property insurance has a deductible. The Contractor shall be responsible for the first $5,000 of such deductible. If the Owner or insurer increases the required minimum deductibles above the amounts so identified or if the Owner elects to purchase this insurance with voluntary deductible amounts, the Owner shall be responsible for payment of the additional costs not covered because of such increased or voluntary deductibles. Contractor’s payment towards the deductible will not exceed $5,000 per occurrence.

Boiler and Machinery Insurance

The Owner shall purchase and maintain boiler and machinery insurance required by the Contract Documents or by law, which shall specifically cover such insured objects during installation and until final acceptance by the Owner; this insurance shall protect the interests of the Owner, Contractor, Subcontractors and Sub-subcontractors in the Work.

Loss of Use Insurance

The Owner, at the Owner’s option, may purchase and maintain such insurance as will insure the Owner against loss of use of the Owner’s property due to fire or other hazards, however caused. The Owner waives all rights of action against the Contractor for loss of use of the Owner’s property, including consequential losses due to fire or other hazards however caused. If the Contractor requests in writing that insurance for risks other than those described herein or for other special hazards be included in the property insurance policy, the Owner shall, if possible, include such insurance, and the cost thereof shall be charged to the Contractor by appropriate Change Order.

The Owners shall file a certificate of insurance with the Contractor upon request.

Waivers of Subrogation

The Owner and Contractor waive all rights against (1) each other and any of their Subcontractors, Sub-subcontractors, agents and employees, each of the other, and (2) the Professional, Professional’s consultants, Separate Contractors described in Article 7, if any, and any of their Subcontractors, Sub-subcontractors, agents and employees, for damages caused by fire or other perils to the extent covered by property insurance obtained pursuant to this Paragraph 3.3 or other property insurance applicable to the

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Work, except such rights as they have to proceeds of such insurance held by the Owner as fiduciary. The Owner or Contractor, as appropriate, shall require of the Professional, Professional’s consultants, Separate Contractors described in Article 7, if any, and the Subcontractors, Sub-subcontractors, agents and employees of any of them, by appropriate agreements, written where legally required for validity, similar waivers each in favor of other parties enumerated herein. The policies shall provide such waivers of subrogation by endorsement or otherwise. A waiver of subrogation shall be effective as to a person or entity even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, did not pay the insurance premium directly or indirectly, and whether or not the person or entity had an insurable interest in the property damaged.

A loss insured under Owner's property insurance shall be adjusted by the Owner as fiduciary and made payable to the Owner as fiduciary for the insureds, as their interests may appear, subject to requirements of any applicable mortgagee clause. The Contractor shall pay Subcontractors their just shares of insurance proceeds received by the Contractor, and by appropriate agreements, written where legally required for validity, shall require Subcontractors to make payments to their Sub-subcontractors in similar manner.

Partial occupancy or use in accordance with Paragraph 10.6 shall not commence until the insurance company or companies providing property insurance have consented to such partial occupancy or use by endorsement or otherwise. The Owner and the Contractor shall take reasonable steps to obtain consent of the insurance company or companies and shall, without mutual written consent, take no action with respect to partial occupancy or use that would cause cancellation, lapse or reduction of insurance.

3.4 PERFORMANCE AND PAYMENT BONDS

At the time of signing the Contract and before it becomes effective, the Contractor and its surety, acceptable to the Owner, shall execute two bonds each in the amount of 100% of the contract price of the Work awarded to the Contractor. The Bonds shall be written by a Surety authorized to do business in the Commonwealth of Pennsylvania and shall be delivered to the Owner prior to award of Contract and within three (3) days of the Owner's request thereof. The Attorney-in-Fact who signs the Bonds must be a resident of the Commonwealth of Pennsylvania and shall file with each Bond a certified and effectively dated copy of the Attorney-in-Fact's Power of Attorney.

One bond shall be a performance bond covering the faithful performance by the Contractor of all covenants and agreements on the part of the Contractor contained in this Contract.

The other bond shall be a labor and material payment bond protecting all parties that have performed labor or supplied material on this Contract from suffering any loss due to the failure of the Contractor to pay any or all obligations incurred under this Contract.

The Contractor shall pay all premiums for all bonds.

Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor or Owner shall promptly furnish a copy of the bonds or shall permit a copy to be made.

ARTICLE 4 - GOVERNING LAWS

4.1 GOVERNING LAW

The Contract shall be governed by the law of the Commonwealth of Pennsylvania. In the event litigation arises out of this Contract, the parties agree to submit any claim to the competent courts of Centre County, Pennsylvania.

4.2 COMPLIANCE WITH LAWS

The Contractor at all times shall observe and comply with all Federal, State and Local laws, by-laws, ordinances, codes and regulations, in any manner affecting the conduct of the Work or applying to any employees on the Project, as well as all orders or decrees which have been promulgated or enacted, or which may be promulgated or enacted during the progress of the Work, by any legal bodies or tribunals having authority or jurisdiction over the Work, materials, employees or the Contract.
Contractor shall indemnify and save harmless the Owner and all its officers, employees and agents from all suits, actions, or claims of any character or description brought for, made on account of, or arising from the violation of any such law, by-law, ordinance, regulation, order or decree.

4.3 PREVAILING WAGE ACT

The Contractor is hereby notified that this Contract is subject to the provisions, duties, obligations, remedies and penalties of the Pennsylvania Prevailing Wage Act, Act No. 442, August 15, 1961 (P.L. 987), and as amended August 8, 1983, Act No. 342; and said Act is incorporated herein by reference as fully as though the same were here set forth at length.

4.4 TAXES

The Contractor shall pay sales, consumer, use and similar taxes for the Work on portions thereof provided by the Contractor which are legally enacted when bids are received, whether or not yet effective or merely scheduled to go into effect.

The Contractor is obligated to pay all Pennsylvania sales tax with the exception of those items for which an exemption might be claimed under Sales and Use Tax Regulation 150 (61 Pa. Code SS31.11–SS31.16).

4.5 ROYALTIES AND PATENTS

The Contractor shall pay all royalties and license fees, and defend all suits or Claims for infringement of any patent rights and shall save the Owner harmless from loss on account thereof, except that the Owner shall be responsible for all such royalties and license fees and loss when a particular design or process, or the product of a particular manufacturer or manufacturers is specified; provided, however, if the Contractor has reason to believe the design, process or product specified constitutes an infringement of a patent, the Contractor shall be responsible for such royalties, license fees and loss unless the Contractor promptly gives such information to the Owner and the Professional.

ARTICLE 5 - STANDARDS, SUBSTITUTIONS, AND SHOP DRAWINGS

5.1 STANDARDS

Whenever a material, product or process is specified by reference to a governmental, trade association or similar standard, it shall comply with the requirements of the latest publication thereof, and amendment thereto, in effect on the bid date. Such standards are as effectively part of the Contract Documents as if therein printed.

5.2 SUBSTITUTIONS

The various materials, products or equipment specified in the Specifications are mentioned for the purpose of establishing a standard of quality and cost. It is not the intent to limit to any one product, but rather to set up the same as the standard desired or acceptable and to establish a basis of equality. Where trade or proprietary names, catalog numbers and manufacturers of materials, products or equipment are used or specified, whether or not followed by the words "or equal as approved by the Professional," materials, products or equipment to be equal in quality to that mentioned in the Specifications will be acceptable. It will be up to the Contractor, supplier and/or vendor to prove by the submission of proper data that their product is equal in quality to that specified.

These standards of quality were established and made only after careful study by the Professional and will, therefore, be strictly adhered to and all substandard materials, products or equipment will be rejected. Each Subcontractor, supplier and/or vendor shall in securing a substitution, submit a request in writing through the Contractor.

This request will then be forwarded to the Professional.

The Contractor shall obtain written approval of the Professional for all such substitutions of material, products, or equipment not less than five (5) working days before bids are due.
When submitting a request for a substitution, the requestor shall clearly indicate the item to be substituted, and shall include all calculations, catalog data, literature and/or drawings, so the substitution can be properly evaluated and processed in the shortest period of time.

Verbal communication regarding substitutions will not be construed as acceptance by the Professional and Owner, only written approvals on all substitutions will be valid.

The Professional will be the sole judge in evaluating and approving substitutions, and the Professional’s decisions with the Owner’s approval will be final.

No substitution for the above-named products or processes will be permitted after award of Contract, except as provided for below.

(i) The Contractor may submit substitute products or processes for consideration, fully documented as stated above, and accompanied by Contractor’s proposal the amount to be deducted from the Contract sum.

(ii) A substitution submitted by the Contractor for reason that a product is not available will not be considered unless written proof is submitted that a firm order for the product was placed within 45 days after Notice to Proceed.

5.3 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

Shop drawings, product data and samples are defined as follows:

5.3.1 Shop Drawings are drawings, diagrams, illustrations, schedules, performance charts, brochures and other data prepared by the Contractor, or any Subcontractor, manufacturer, supplier or distributor which illustrate some portion of the Work.

5.3.2 Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.

5.3.3 Samples are physical examples furnished by the Contractor to illustrate materials, equipment or workmanship, and to assist in the establishment of standards by which the Work will be judged.

Shop Drawings, Product Data and Samples are not Contract Documents. The purpose of their submittal is to demonstrate how the Contractor proposes to comply with the information given and the design concept outlined in the Contract Documents.

5.3.4 Shop Drawing Submittal Schedule: Based on the priorities of the construction schedule, the Contractor shall submit a shop drawing submittal schedule on or before the Second Regular Job Conference.

The Professional shall review and check the shop drawing submittal schedule within fifteen (15) days of receipt from the Contractor.

The Contractor shall thereafter submit all shop drawings, product data and samples in accordance with the approved submittal schedule.

The Contractor shall review all shop drawings, product data and samples for compliance with the Contract Documents and shall certify that the Contractor has done so by stamp, or otherwise, affixed to each copy thereof. Submittal data presented without such certification will be returned without review or other comment, and any delay resulting therefrom will be the Contractor’s responsibility. At the time of submission, the Contractor shall inform the Professional and Owner in writing of any deviation in the shop drawings, product data or samples from the requirements of the Contract Documents.

By approving and submitting shop drawings, product data and samples, the Contractor thereby represents that the Contractor has determined and verified all field measurements, field construction criteria, materials, catalog numbers and similar data, or will do so, and that the Contractor has checked and coordinated each shop drawing, product data and sample with the requirements of the Work and the Contract Documents and shall so certify as required above.
The Professional shall review, approve and process, subject to the right of review by the Owner, shop drawings, product data, samples, and other submissions of the Contractor as to compliance with the Contract Documents and for conformity to and harmony with the design concept of the Project and for compliance with the requirements of the Contract Documents. The Professional shall not approve any substitution of or deviation from specified materials and/or equipment without first obtaining the Owner’s consent.

The Professional shall return the approved shop drawings or detailed notation for resubmission if required, within twenty-one (21) days after receipt from the Contractor. The Professional shall act on any resubmissions within fifteen (15) calendar days of receipt thereof. A detailed log shall be maintained by the Professional as to time of receipt of the shop drawings and time of return with adequate notes as to their disposition.

If the Contractor considers any correction indicated on the revised shop drawings to constitute a change to the Contract Drawings or Specification, written notice shall be given promptly to the Owner and the Professional.

The Contractor shall make any corrections required and shall resubmit the required number of corrected copies of the shop drawings, product data, or new samples of materials until approved. The Contractor shall direct specific attention in writing to any new revisions other than the corrections requested on previous submissions. No Work requiring a shop drawing, product data, or sample submission shall be commenced until the submission has been approved. All such Work shall be in accordance with contract documents which shall include approved shop drawings, product data, and samples.

The approval of the shop drawings, product data or samples shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents unless the Contractor has informed the Owner and the Professional in writing of such deviation at the time of submission and the Owner or the Professional has not objected to the specific deviation. The approval shall not relieve the Contractor from responsibility for errors or omissions in the shop drawings, product data, or samples. The approval of a separate item shall not indicate approval of an assembly in which the item functions.

The Owner reserves the right to review all Submittal data. No Work required by these submittals shall be commenced until the submittal has been approved by the Professional and Owner.

The approval of shop drawings, product data and samples by the Professional shall not be construed as a complete check, but will indicate only that the general method of construction and detailing is satisfactory. Approval of shop drawings, product data and samples will not relieve the Contractor of the responsibility for any error which may exist therein, and the Contractor shall be responsible for the dimensions and design of adequate connections, details, and the satisfactory construction of all Work.

Work done contrary to this procedure shall be at the risk and expense of the Contractor. All shop drawings used for fabrication and erection shall be those approved by the Professional, without change. If change is found to be necessary on any approved shop drawings or sample, it shall be resubmitted to the Professional for review and approval.

The number of copies of shop drawings and other submittals will be established at the Initial Job Conference. The Contractor shall bear the cost of all required shop drawing reproductions and scanning, if applicable. The project may opt to use an electronic submittal process and the Contractor shall bear the cost of all submissions in the required electronic .pdf format.

If the project opts to use an electronic submittal process the Contractor is required to submit a complete set of approved electronic submittals in .pdf format organized by CSI division to the Owner at the time of Substantial Completion.

All Operation and Maintenance data is required to be submitted in electronic .pdf format to the Owner subsequent to approval by the Professional. The Contractor is required to organize information by system and CSI division. Exact requirements to be outlined by the Owner. One hard copy may also be requested by the Owner.
ARTICLE 6 - KNOWLEDGE OF CONTRACT REQUIREMENTS

6.1 NOTICE

The Contractor, its Subcontractors and materialmen shall consult in detail the Project Manual, the General Conditions of the Contract, all Divisions and Sections of the Specifications, all Drawings, and all Addenda to the Project Manual for instructions and requirements pertaining to the Work, and at its and their cost shall provide all labor, materials, equipment and services necessary to furnish, install and complete the Work in strict conformance with all provisions thereof.

6.2 EXAMINATION AND CONDITIONS AT THE SITE

The Contractor is responsible for having visited the site and having ascertained and informed itself, its Subcontractors and materialmen, of all pertinent local conditions such as location, accessibility, and general character of the site or building, the character and extent of existing Work within and adjacent to the site, any other Work being performed thereon at the time of the submission of the Contractor's proposal, and subsurface conditions. Any failure to do so will not relieve the Contractor from responsibility for successfully performing the Work without additional expense to the Owner.

6.3 EXAMINATION OF CONTRACT DOCUMENTS

The Contractor will be held to have examined the Contract Documents, and Modifications thereto, as they may affect subdivisions of the Work and to have informed itself, its Subcontractors, Sub-subcontractors and materialmen of all conditions thereof affecting the prosecution of the Work.

The Scope of the Work for the Contract is not necessarily limited to the description of each section of the Specifications and the illustrations shown on the drawings. Include all minor items not expressly indicated in the Contract Documents, or as might be found necessary as a result of field conditions, in order to complete the Work as it is intended, without any gaps between the various subdivisions of Work of the Contractor, or between the Work of all Subcontractors.

The Contractor shall at once report to the Professional errors, inconsistencies or omissions discovered. The Contractor shall not be liable to the Owner or Professional for damage resulting from errors, inconsistencies or omissions in the Contract Documents unless the Contractor recognized such error, inconsistency or omission and failed to report it to the Professional. If the Contractor performs any construction activity knowing it involves a recognized error, inconsistency or omission in the Contract Documents without such notice to the Professional, the Contractor shall assume appropriate responsibility for such performance and shall bear an appropriate amount of the attributable costs for correction.

6.4 LABOR

The Contractor will be held to be thoroughly familiar with all conditions affecting labor in the location of the Project, including, but not limited to, unions, incentive pay, procurement, living and commuting conditions, and to have informed its Subcontractors and Sub-subcontractors thereof.

ARTICLE 7 - CONTRACT ADMINISTRATION

7.1 GENERAL ADMINISTRATION

The Professional will provide general administration of the Contract beginning with the execution of the Agreement between the Contractor and the Owner until expiration of the Contractor's one year guarantee period against defective materials, equipment and/or workmanship.

The Professional shall advise and consult with the Owner and will have authority to act on behalf of the Owner to the extent provided in the Contract Documents. The extent of the Professional's duties and responsibilities and the limitations of the Professional's authority as outlined hereunder shall not be modified without written agreement between the Owner and the Professional.

7.2 CONTRACT ADMINISTRATION COMMUNICATIONS AND INTERPRETATION

7.2.1 Communications: The Owner assumes no responsibility for any understanding given or representation made orally by the Owner's agents prior to the execution of this Contract,
unless such understanding(s) or representation(s) are expressly stated in the Contract. The Owner assumes no responsibility for any conclusions or interpretations made by the Contractor. Any failure by the Contractor to become acquainted with available information will not relieve the Contractor from responsibility for properly estimating the difficulty or cost of successfully performing the Work or mutually agreed changes thereto.

The Owner's instructions to the Contractor will generally be issued through the Professional except that the Owner reserves the right on appropriate occasions to issue instructions directly to the Contractor through the Owner's designated representative.

Communications by and with the Professional's consultants shall be through the Professional. Communications by and with Subcontractors and material suppliers shall be through the Contractor. Communications by and with the Owner's Separate Contractors shall be through the Owner.

All instructions affecting contract sum, contract time, or contract interpretation shall be confirmed expeditiously in writing with copies furnished to the Professional, the Owner's designated representatives, and the Contractor by the party issuing the instruction. No instruction affecting the Professional's design liability shall be issued without the Professional's prior written consent.

7.2.2 Interpretation: The Professional will be, in the first instance, the interpreter of the requirements of the Contract Documents. The Professional will, within a reasonable time, render such interpretation as the Professional may deem necessary for the proper execution or progress of the Work. All interpretations by the Professional shall be defined in writing and/or by drawing and shall be consistent with the intent of the Contract Documents. In its capacity as interpreter, the Professional will exercise its best efforts to insure faithful performance by the Contractor.

The Professional's decisions on matters relating to aesthetic effect will be final with the Owner's consent and if consistent with the intent expressed in the Contract Documents.

7.3 ACCESS TO AND INSPECTION OF THE WORK

The Professional, the Owner and their authorized representatives shall be provided full and safe access to the Work at all times by the Contractor for their observation and/or inspection of same.

The Professional, or an authorized and qualified representative, shall visit the project periodically as required by the Owner during periods of active construction, review the progress of the Work, and take such actions as in the Professional's judgment are necessary or appropriate to achieve the requirements of the Contract Drawings and Specifications in the Work of the Contractor, including advising the Owner as to particular matters to watch and guard against. The Professional will have its consultants visit the site periodically as required during their respective phases of the Work at such intervals as may reasonably be deemed necessary by the Owner and the Professional, to review their respective phases of the Work in order to achieve the requirements of the Contract Drawings and Specifications.

In addition to the above, the Professional shall be required to attend, at the determination of the Owner, any and all project site conferences dealing with interpretation of the Contract Documents.

The Owner shall be consulted by the Contractor on matters pertaining to the Work and shall transmit instructions of the Professional regarding the Work to the Contractor.

The Owner will, in addition to the Professional's inspection, inspect all Work under Contract. While the Owner will assist the Contractor in obtaining additional information in explanation of the Contract Documents and will serve as liaison between the Contractor and the Professional, the Owner is not empowered to authorize deviations from the Contract, except by a written modification as identified in Paragraph 1.1, nor to enter into the Contractor's area of responsibility for supervision and construction means, methods, techniques, sequences, procedures or coordination or for safety of persons and property. The fact that the Owner may have permitted faulty Work or Work not in accordance with the Contract Documents to be performed shall not relieve the Contractor from any responsibility to perform fully in accordance with the Contract.
The Work will be subject to inspection by the Owner and by representatives of the Professional as outlined above; however, such representatives are not authorized to make oral changes in any provision of the Drawings or Specifications except as provided in Article 9, Changes in the Work. Changes resulting from such inspections will be processed in the manner prescribed in Article 9. The absence or presence of the Owner shall not relieve the Contractor from any requirements of the Contract.

The Owner reserves the right to inspect, at their sources, all materials, supplies or services not manufactured or performed within the Contractor’s on-site facility. Such inspection shall not constitute acceptance, nor shall it replace in any way the Contractor’s responsibility for inspection or requirement to furnish acceptable materials.

The Owner will notify the Contractor of any non-compliance with the Contract Documents and the action required; and, the Contractor shall take immediate corrective action. If the Contractor fails or refuses to take prompt action, the Owner may issue an order stopping all or part of the Work until the Contractor takes appropriate action. No part of the time lost due to any such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

7.4 SEPARATE CONTRACTS

The Owner reserves the right to award other, separate contracts in connection with other portions of the Project under these or similar conditions of the Contract and/or to perform construction or operations related to the Project with the Owner’s own forces.

When separate contracts are awarded for different portions of the Project, the term “this Contractor” shall mean the Contractor referred to in these Contract Documents, and the term “Separate Contractor” shall mean the Contractor who executes each separate Owner/Contractor Agreement.

If part of this Contractor’s Work depends for proper execution or results upon construction or operations by the Owner or a Separate Contractor, this Contractor shall, prior to proceeding with that portion of the Work, promptly report to the Professional apparent discrepancies or defects in such other construction that would render it unsuitable for such proper execution and results. Upon receipt of such report, the Professional shall make a determination as to the unsuitability of such other construction. Failure of this Contractor to so report shall constitute an acknowledgment that the Owner’s or Separate Contractor’s completed or partially completed construction is fit and proper to receive the Contractor’s Work, except as to defects not then reasonably discoverable and which may develop in the Owner’s or Separate Contractor’s construction after the execution of this Contractor’s Work.

This Contractor shall promptly remedy damage wrongfully caused by this Contractor to completed or partially completed construction or to property of the Owner or Separate Contractors. Should this Contractor cause damage to the Work or property of any Separate Contractor on the Project, this Contractor shall, upon due notice, endeavor to settle with such other Contractor by agreement. If such Separate Contractor sues the Owner on account of any damage alleged to have been so sustained, the Owner shall notify this Contractor who shall defend such proceedings and pay all costs in connection therewith, and if any judgment against the Owner arises therefrom, this Contractor shall pay or satisfy it.

This Contractor shall afford the Owner and Separate Contractors reasonable opportunity for introduction and storage of their materials and equipment and performance of their activities and shall connect and coordinate this Contractor’s construction and operations with theirs as required by the Contract Documents.

7.5 CLAIMS AND DISPUTES

7.5.1 Claims: Claims by either party must be made within twenty-one (21) days after occurrence of the event giving rise to such Claim or within twenty-one (21) days after the claimant first becoming aware or reasonably should have become aware of the condition giving rise to the Claim, whichever is later. Claims must be made by written notice. An additional Claim made after the initial Claim has been implemented by Change Order will not be considered unless submitted in a timely manner.

Pending final resolution of a Claim unless otherwise agreed in writing, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make payments in accordance with the Contract Documents.
7.5.2 Claims for Concealed or Unknown Conditions: If conditions are encountered at the site which are (1) subsurface or otherwise concealed physical conditions which differ materially from those indicated in the Contract Documents or discoverable by the Contractor or (2) unknown physical conditions of an unusual nature, which differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, then notice by the observing party shall be given to the other party promptly before conditions are disturbed and no later than forty-eight (48) hours after first observance of the conditions. The Professional will promptly investigate such conditions and, if they differ materially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the Work, will recommend an equitable adjustment in the Contract Sum or Contract Time, or both. If the Professional determines that the conditions at the site are not materially different from those indicated in the Contract Documents or discoverable by the Contractor and that no change in the terms of the Contract is justified, the Professional shall so notify the Owner and Contractor in writing, stating the reasons. Claims by either party in opposition to such determination must be made within twenty-one (21) days after the Professional has given notice of the decision.

The failure by the Contractor to make the written notice and claims as provided in this subparagraph shall constitute a waiver by the Contractor of any claim arising out of or relating to such concealed or unknown condition.

7.5.3 Claims for Additional Cost: If the Contractor wishes to make Claim for an increase in the Contract Sum, the Contractor shall give written notice of such claim to the Professional and the Owner within twenty-one (21) days after the occurrence of the event or first appearance of the condition giving rise to such Claim and before proceeding to execute the Work. The failure by the Contractor to give such notice within the time permitted and prior to executing the Work shall constitute a waiver of claim for additional compensation. Prior notice is not required for Claims relating to an emergency endangering life or property arising under Paragraph 8.5.

In connection with any claim by the Contractor against the Owner for compensation in excess of the Contract Price, any liability of the Owner for the Contractor's costs shall be strictly limited to direct costs incurred by the Contractor and shall in no event include indirect costs or consequential damages of the Contractor. The Owner shall not be liable to the Contractor for claims of third parties, including Subcontractors, unless and until liability of the Contractor has been established therefore in a court of competent jurisdiction.

7.5.4 Claims for Additional Time: If the Contractor wishes to make Claim for an increase in the Contract Time, written notice as provided herein shall be given to the Professional and the Owner at the time of any Change Order proposal submitted. If the Contractor believes additional time is involved for reasons including but not limited to (1) changes ordered to the Contract or because of (2) strikes, (3) lockouts, (4) fire, (5) unusual delay in transportation, (5) or any cause beyond the Contractor's control, which constitute a justifiable delay, Claim shall be filed in accordance with the procedure established herein.

If unusual inclement weather conditions are the basis for a Claim for additional time, such Claim shall be documented by data substantiating that weather conditions were abnormal for the period of time and could not have been reasonably anticipated, and that weather conditions prevented the execution of major and/or critical items of the Work.

Unusual inclement weather as used herein means unusually severe weather which is beyond the normal weather recorded and expected for the locality and/or the season or seasons of the year. Normal weather shall be determined based on records for the closest stations of the United States Environmental Data Service and for a period of ten (10) years.

Any claim for extension of time on account of labor strike or lock-out shall be supported by a certificate of all facts concerning the strike, including, but not limited to, the dates, the craft(s) concerned, the reason for the strike, efforts to resolve the dispute, and efforts to minimize the impact of the strike on progress.

Any claim for extension of time on account of delays in transportation, or for failure of
suppliers, shall be supported by a certificate of all the facts involved, demonstrating that the delays were beyond the Contractor's control and including, but not limited to, the Contractor's efforts to overcome such delays.

If the Contractor fails to make such claim as required in this subparagraph within twenty-one (21) days of such occurrence giving rise to the claim, any claim for extension of time shall be waived.

7.5.5 Injury or Damage to Person or Property: If either party to the Contract suffers injury or damage to person or property because of an act or omission of the other party, of any of the other party’s employees or agents, or of others for whose acts such party is legally liable, written notice of such injury or damage, whether or not insured, shall be given to the other party within a reasonable time not exceeding twenty-one (21) days after first becoming aware of such injury or damage. The notice shall provide sufficient detail to enable the other party to investigate the matter. If a Claim for additional cost or time relates to this Claim is to be asserted, it shall be filed as provided in Subparagraphs 7.5.3 or 7.5.4 respectively.

7.5.6 Decision of the Professional: Claims, including those alleging an error or omission by the Professional, shall be referred initially to the Professional for action as provided in Subparagraph 7.5.7. A decision by the Professional, as provided in Subparagraph 7.5.7, shall be required as a condition precedent to litigation of a Claim between the Contractor and Owner as to all such matters arising prior to the date final payment is due, regardless of whether such matters relate to execution and progress of the Work or (2) the extent to which the Work has been completed. The decision by the Professional in response to a Claim shall not be a condition precedent to litigation in the event (1) the position of Professional is vacant, (2) the Professional has not received evidence or has failed to render a decision within agreed time limits, (3) the Professional has failed to take action required under Subparagraph 7.5.7 within thirty (30) days after the Claim is made, (4) forty-five (45) days have passed after the Claim has been referred to the Professional.

7.5.7 Resolution of Claims and Disputes: The Professional will review Claims and take one or more of the following preliminary actions within ten (10) days of receipt of a Claim: (1) request additional supporting data from the claimant, (2) submit a schedule to the parties indicating when the Professional expects to take action, (3) reject the Claim in whole or in part, stating reasons for rejection, (4) recommend approval of the Claim by the other party or (5) suggest a compromise. The Professional may also, but is not obligated to, notify the surety of the nature and amount of the Claim.

If a Claim has been resolved, the Professional will prepare or obtain appropriate documentation.

If a Claim has not been resolved, the party making the Claim shall, within ten (10) days after the Professional's preliminary response, take one or more of the following actions: (1) submit additional supporting data requested by the Professional, (2) modify the Initial Claim or (3) notify the Professional that the Initial Claim stands.

If a Claim has not been resolved after consideration of the foregoing and of further evidence presented by the parties or requested by the Professional, the Professional will notify the parties in writing that the Professional's decision will be made within seven (7) days. Upon expiration of such time period, the Professional will render to the parties the Professional's written decision relative to the Claim, including any change in the Contract Sum or Contract Time or both. If there appears to be a possibility of a Contractor's default, the Professional may, but is not obligated to, notify the surety and request the surety's assistance in resolving the controversy.

7.6 CONTRACT TERMINATION

7.6.1 Termination by Contractor: If the Work is stopped for a period of ninety (90) days under an order of any court or other public authority having jurisdiction, or as a result of an act of government, such as a declaration of a national emergency making materials unavaiable, through no act or fault of the Contractor or a Subcontractor or their agents or employees or
any other persons performing any of the Work under a contract with the Contractor, then the Contractor may, upon ten (10) additional days' written notice to the Owner and the Professional, terminate the Contract and recover from the Owner payment for all Work executed and for any loss sustained upon any materials, equipment, tools, construction equipment and machinery, including reasonable profit associated with such Work or losses and reasonable expenses resulting from such termination.

If the cause of the Work stoppage is removed prior to the end of the ten (10) day notice period, the Contractor may not terminate the Contract.

7.6.2 Termination by Owner: If the Contractor refuses or fails, except in cases for which extension of time is provided, to supply enough properly skilled workmen or proper materials to perform the Work, or disregards laws, ordinances, rules, regulations or orders of any public authority having jurisdiction, or otherwise is in violation of a provision of the Contract Documents, or fails to so prosecute the Work as to insure its completion, within the time, or any extension thereof, specified in this Contract, then the Owner may, without prejudice to any right or remedy and after giving the Contractor and its surety ten (10) days' written notice, terminate the Work and services of the Contractor and take possession of the site and of all materials, equipment, tools, construction equipment and machinery thereon owned by the Contractor. In such case, the Contractor shall not be entitled to receive any further payment until the Work is finished.

If the Contractor shall generally not pay its debts as they become due or shall admit in writing its inability to pay its debts, or shall make a general assignment for the benefit of creditors; or if the Contractor shall commence any case, proceeding or other action seeking to have an order for relief entered in its behalf as debtor or to adjudicate it as bankrupt or insolvent, or seeking reorganization, arrangement, adjustment, liquidation, dissolution or composition of it or its debts under any law relating to bankruptcy, insolvency, reorganization or relief of debtors or seeking appointment of a receiver, trustee, custodian or other similar official for it or for all or any substantial part of its property; or if the Contractor shall take any action to authorize or in contemplation of any of the actions set forth above in this paragraph, then this Agreement will automatically terminate upon written notification by Owner to Contractor and its surety.

Should the surety fail to respond within fifteen (15) days following the date of the notice of termination given to the surety and fail to pursue completion of the Work with diligence acceptable to the Owner, the Owner may arrange for completion of the Work and deduct the cost thereof from the unpaid Contract Sum remaining, including the cost of additional professional services made necessary by such default or neglect, in which event no further payment shall then be made by the Owner until all costs of completing the Work shall have been paid.

If the unpaid balance of the Contract Sum exceeds the costs of finishing the Work, including compensation for the Professional's additional services made necessary thereby, such excess shall be paid to the Contractor. If such costs exceed the unpaid balance, the Contractor or its surety shall pay the difference to the Owner. This obligation for payment shall survive the termination of the Contract.

7.6.3 Termination for Convenience of Owner: Prior to, or during the performance of the Work, the Owner reserves the right to terminate the Contract for unforeseen causes including but not limited to court orders, loss of funding, acts of the federal government to discontinue the Work, etc., that may occur. Upon such an occurrence, the following procedures will be adhered to:

7.6.3.1 The Owner will immediately notify the Professional and the Contractor in writing, specifying the effective termination date of the Contract.

7.6.3.2 After receipt of the notice of termination, the Contractor shall immediately proceed with the following obligations, regardless of any delay in determining or adjusting any amounts due at that point in the Contract:

(1) Stop all Work.
(2) Place no further subcontracts or orders for materials or services.
(3) Terminate all subcontracts.
(4) Cancel all material and equipment orders as applicable.
(5) Take action that is necessary to protect and preserve all property related to this Contract which is in the possession of the Contractor.

7.6.3.3 Within one hundred eighty (180) days of the date of the notice of termination, the Contractor shall submit a final termination settlement proposal to the Owner based upon costs up to the date of termination, reasonable profit on Work done only, and reasonable demobilization costs. If the Contractor fails to submit the proposal within the time allowed, the Owner may determine the amount due to the Contractor because of the termination and shall pay the determined amount to the Contractor.

7.6.3.4 If the Contractor and the Owner fail to agree on the settlement amount, the matter will be handled as a dispute through the procedures as outlined in Subparagraphs 7.5.6 and 7.5.7.

7.6.4 Written Notice: Written notice shall be considered to have been duly given if delivered in person to the individual or member of the firm or to an officer of the corporation for whom it is intended, or if delivered at or sent by United States mail to the last business address known.

ARTICLE 8 - CONSTRUCTION

8.1 CONSTRUCTION SCHEDULE, FIELD MEASUREMENTS AND SUPERVISION

8.1.1 Construction Schedule: The Contractor, promptly after being awarded the Contract, shall prepare and submit for approval by the Professional, a construction schedule for the Work. The schedule shall not exceed time limits as contained in the Contract Documents, shall be revised at appropriate intervals as required by the conditions of the Work and Project, shall be related to the entire Project to the extent required by the Contract Documents, and shall provide for expeditious and practicable execution of the Work.

The construction schedule shall be coordinated with the Contractor's shop drawing submittal schedule.

8.1.2 Field Measurements: The Contractor shall take field measurements and verify field conditions and shall carefully compare such field measurements and conditions and other information known to the Contractor with the Contract Documents before commencing activities. Errors, inconsistencies or omissions discovered shall be reported to the Professional at once.

8.1.3 Supervision: The Contractor shall supervise and direct the Work. The Contractor shall be solely responsible for all construction means, methods, techniques, safety, sequences and procedures, and for coordinating all portions of the Work under the Contract. The Contractor shall be responsible for inspection of portions of Work already performed under this Contract to determine that such portions are in proper condition to receive subsequent Work.

The Contractor shall employ a competent superintendent who shall be in attendance at the Project site during the progress of the Work. The superintendent shall be satisfactory to the Owner, and shall not be changed except with the written approval of the Owner unless the superintendent leaves the employment of the Contractor. The superintendent shall represent the Contractor and shall have full authority to act on the Contractor's behalf. All communications given to the superintendent shall be as binding as if given to the Contractor. All oral communications affecting contract time, contract cost and contract interpretation will be confirmed in writing.

8.2 SUBCONTRACTS

As soon as practicable after the execution of the Contract, the Contractor shall submit to the Professional, for approval, a list of all Subcontractors, including those who are to furnish materials or equipment; that
the Contractor and/or its major Subcontractors propose to employ in the construction of the Project. The Contractor shall not employ any Subcontractor to whom the Professional or Owner may have an objection.

A change in any approved Subcontractor or the addition of any new Subcontractor can only be made with the written approval of the Owner and Professional.

The Contractor agrees to bind every Subcontractor, and every Subcontractor agrees to be bound, by the terms of the Agreement, the General Conditions of the Contract, and the Drawings and Specifications insofar as they are applicable to the Subcontractor's respective portion of the Work. The Contractor shall further more fully inform each of its Subcontractors, prior to executing an agreement with, conformance with related documents and to submit Cost Estimates and Change Order proposals in complete and full analytical detail when so required or requested. The Contractor shall indemnify the Owner for any Subcontractor's claim which may result from the failure of the Contractor to incorporate the provisions of this Contract in the Contractor's agreements with any of its Subcontractors.

8.2.1 **Contingent Assignment of Subcontracts:** Each subcontract agreement for a portion of the Work is hereby assigned by the Contractor to the Owner provided that:

8.2.1.1 Assignment is effective only after termination of the Contract by the Owner for cause pursuant to Subparagraph 7.6.2 and only for those subcontract agreements which the Owner accepts by notifying the Subcontractor in writing.

8.2.1.2 Assignment is subject to the prior rights of the surety obligated under bond relating to the Contract.

8.3 **PERMITS, FEES AND NOTICES**

The Contractor shall secure and pay for, with the exception of the building permit, all other permits, fees, licenses and inspections necessary for the proper execution and completion of the Work which are customarily secured after execution of the Agreement and which are legally required.

It is not the Contractor's responsibility to ascertain that the Contract Documents are in accordance with applicable laws, statutes, ordinances, building codes, and rules and regulations. However, if the Contractor observes that portions of the Contract Documents are at variance therewith, the Contractor shall promptly notify the Professional and Owner in writing, and necessary changes shall be accomplished by appropriate modification.

If the Contractor performs Work knowing it to be contrary to laws, statutes, ordinances, building codes, and rules and regulations without such notice to the Professional and Owner, the Contractor shall assume full responsibility for such Work and shall bear the attributable costs.

8.4 **ACTS AND OMISSIONS**

The Contractor shall be responsible for acts and omissions of the Contractor's employees and Subcontractors, their agents and employees and other persons performing portions of the Work under a contract with the Contractor.

The Contractor shall not be relieved of obligations to perform the Work in accordance with the Contract Documents either by activities or duties of the Professional in the Professional's administration of the Contract, or by tests, inspections or approvals required or performed by persons other than the Contractor.

8.5 **PROTECTION OF PERSONS AND PROPERTY**

8.5.1 **OSHA:** It shall be the duty and responsibility of the Contractor and all its Subcontractors and their agents and employees, and other persons performing portions of the Work under a contract with the Contractor to be familiar and comply with all requirements of Public Law 91-596, the Occupational Safety and Health Act of 1970 (OSHA) and all amendments thereto, and to enforce and comply with all of the provisions of this Act.
8.5.2 Safety: Safety is the utmost importance to the Owner. Therefore, at a minimum, the Owner requires the following:

A. The Contractor must provide a site specific written safety program. The safety plan must address all public interfaces, critical activities, and overall project safety. The first pay application will not be processed until this safety plan submission is received.

B. The Contractor's on-site superintendent must be 30-hour OSHA certified. Proof of certification is required. Date of certification must be within (6) years of the start of the project.

C. The Contractor's Safety Director must visit the site on a monthly basis. Inspection report from the site visit must be distributed to the Owner.

D. 100% eye protection is required on the construction site. Eye protection must be ANSI approved safety glasses.

E. OSHA recordable accident data must be submitted to the Owner prior to final payment.

Note: Receiving a satisfaction rating of 'Poor' in the safety section of the contractor performance evaluation conducted during construction or after completion of the project is grounds for immediate complete (all trades) removal from the Office of Physical Plant contractor prequalification listing.

8.5.3 Emergencies: In an emergency affecting safety of persons or property, the Contractor shall act, at its discretion, to prevent threatened damage, injury or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be considered in accordance with Paragraph 7.5 and Article 9.

8.5.4 Precautions: The Contractor shall take appropriate precautions for safety of and shall provide necessary protection to prevent damage, injury or loss to:

8.5.4.1 Employees of the Owner at the Work and other persons who may be affected thereby.

8.5.4.2 The Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody or control of the Contractor or the Contractor's Subcontractors or Sub-subcontractors.

8.5.4.3 Other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not designated for removal, relocation or replacement in the course of construction.

The Contractor shall erect and maintain, as required by existing conditions and performance of the Contract, all necessary safeguards for safety and protection, including posting of danger signs, installing project fencing, and other warnings against hazards.

When the use of explosives are necessary for execution of the Work and such use is approved by the Owner, the Contractor shall conform to the procedures specified.

The Contractor shall not load or permit any part of the construction or site to be loaded so as to endanger its safety.

8.5.5 Hazardous Material: The Contractor and all its Subcontractors and their agents and employees and other persons performing portions of the Work under a contract with the Contractor shall have no responsibility for the discovery, presence, handling, removal or disposal of, or exposure of persons to hazardous materials in any form at the Project site, including but not limited to asbestos, asbestos products, polychlorinated biphenyl (PCB) or other toxic material.

If the Contractor encounters or suspects hazardous or toxic material, the Contractor shall advise the Owner immediately.
The Work in the affected area shall not be resumed by the Contractor until the hazardous material has been removed or rendered harmless by the Owner.

8.5.6 **Property Damage Repair:** The Contractor shall promptly remedy any damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in Subparagraphs 8.5.4.2 and 8.5.4.3 caused in whole or in part by the Contractor, a Subcontractor, their agents and employees or any other persons performing portions of the Work under a contract with the Contractor.

### 8.6 MATERIALS AND WORKMANSHIP

The Contractor shall provide and pay for labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation and other facilities and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

All Work shall be executed in accordance with the Contract Documents, complete in all parts and in accordance with approved practices and customs, the finish specified and of the best workmanship. Unless otherwise specified, all materials and equipment incorporated in the Work under the Contract shall be new.

The Contractor shall provide, without extra charge, all incidental items required as a part of the Work, even though not particularly specified nor indicated and, if the Contractor has good reason for objecting to the use of a material, appliance, or method of construction as shown or specified, the Contractor shall register its objections to the Professional, in writing, sending a copy to the Owner; otherwise, the Contractor shall proceed with the Work, with the understanding that a satisfactory job is required.

8.6.1 **Use of Site:** The Contractor shall confine operations at the site to areas indicated in the Contract Documents and shall not unreasonably encumber the site with materials or equipment.

Subject to prior approval of the Owner, the Contractor may use spaces within the building for shops and the storage of materials and equipment. Every space so used shall be repaired, patched, cleaned and restored to new condition by the Contractor.

8.6.2 **Cutting and Patching:** The Contractor shall be responsible for cutting, fitting or patching required to complete the Work or to make its parts fit together properly.

The Contractor shall not damage or endanger any portion of the Work or fully or partially completed construction of the Owner or Separate Contractors by cutting, patching or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter such construction by the Owner or a Separate Contractor except with consent of the Owner and of such Separate Contractor; such consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold from the Owner or a Separate Contractor the Contractor's consent to cutting or otherwise altering the Work.

The Contractor or a Subcontractor or Sub-subcontractor requiring the cutting of openings in, or relocation of, Work installed by others shall have such openings cut and patched and relocations made by the trade skilled in performing the particular Work; and such cutting, patching and relocation shall be at the expense of the Contractor, Subcontractor, or Sub-subscontractor requiring the opening or relocation.

### 8.7 TESTS AND INSPECTIONS

Tests, inspections and approvals of portions of the Work required by the Contract Documents or by laws, ordinances, rules, regulations or orders of authorities having jurisdiction shall be made at an appropriate time. The Contractor shall schedule and coordinate such tests, inspections and approvals with the independent testing laboratory. The Owner or Owner's agent will retain the testing services unless indicated otherwise by the contract documents. The Contractor shall give the Professional timely notice of when and where tests and inspections are to be made so the Professional may observe such procedures.
In addition, the Owner or the Professional may require special inspection, testing or approval of material or Work for compliance with the requirements of the Contract Documents. Upon direction of the Owner and Professional, the Contractor shall promptly arrange for such special testing, inspection or approval procedure. Should the material or Work fail to comply with the requirements of the Contract Documents, the Contractor shall bear all costs of the testing, inspection or approval as well as the cost of replacement of unsatisfactory material or Work as provided by Paragraph 8.8; otherwise, the Owner shall bear such costs and an appropriate Change Order shall be issued.

8.8 UNCOVERING, REJECTION AND CORRECTION OF WORK

8.8.1 Uncovering of Work: If any portion of the Work is covered contrary to the Professional’s or the Owner’s request or to the requirements of the Contract Documents, it must, if requested by the Professional or Owner, be uncovered for observation by the Professional or Owner. All costs of uncovering, recovering and replacing of Work not installed in accordance with the Contract Documents shall be borne by the Contractor and with no change in Contract Time.

Any other portion of the Work requested to be uncovered by the Professional or the Owner and found not to be in accordance with the Contract Documents shall be replaced by the Contractor. The Contractor shall bear all the costs of uncovering and replacing of such Work. If the portion of Work uncovered is found to be in accordance with the Contract Documents, the costs of uncovering and recovering shall be paid by the Owner by appropriate Change Order.

8.8.2 Rejection and Correction of Work: Any Work rejected by the Professional or the Owner or found not to be in accordance with the Contract Documents shall be corrected promptly by the Contractor at its cost and with no change in Contract Time.

The Contractor shall bear the cost of correcting destroyed or damaged construction, whether completed or partially completed, of the Owner or separate Contractors caused by the Contractor’s correction or removal of Work which is not in accordance with the requirements of the Contract Documents.

If the Contractor fails to correct rejected or nonconforming Work, the Owner may correct it in accordance with Paragraph 8.9.

8.8.3 Acceptance of Nonconforming Work: If the Owner prefers to accept Work found not to be in accordance with the Contract Documents, the Owner may do so, in which case the Contract Sum will be reduced downward appropriately as determined by the Owner.

8.9 OWNER’S RIGHT TO STOP AND/OR CARRY OUT THE WORK

8.9.1 Owner’s Right to Stop the Work: If the Contractor fails to correct rejected or nonconforming Work as required in Subparagraph 8.8.2 or fails to carry out Work in accordance with the Contract Documents the Owner may, in writing, order the Contractor to stop the Work, or any portion thereof until the proper corrective action has been implemented.

8.9.2 Owner’s Right to Carry Out the Work: If the Contractor fails or neglects to carry out the Work in accordance with the Contract Documents, or ceases Work for a period of seven (7) consecutive days, the Owner may, without prejudice to other remedies the Owner may have, perform or cause to be performed the Work.

In such case an appropriate Change Order shall be issued deducting from payments then or thereafter due the Contractor the cost of performing Work pursuant to this subsection. If payments then or thereafter due the Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner.

8.10 CLEANUP

The Contractor shall keep the premises clean at all times of dirt, rubbish and debris resulting from the Work, and shall remove rubbish and debris in metal containers at the end of each working day. The Contractor shall remove rubbish and cartons resulting from the installation of fixtures and equipment. Prior to substantial completion of the Work, the Contractor shall do the final cleaning and polishing of the...
surfaces of the Contractor's installations as may be required by the various Specifications sections. The Contractor, in addition, shall employ a professional cleaning organization to remove all paint and stains from glass, and to wash all glass, throughout the Work, to clean and polish the finished surface of all fixtures, equipment and accessories and to vacuum clean all floors.

If the Contractor fails to clean up as outlined above, the Owner may do so and the cost thereof shall be charged to the Contractor.

8.11 CONSTRUCTION WASTE MANAGEMENT

The contractor is required to recycle and/or salvage 75% of construction, demolition, and land clearing waste. A waste management plan is to be developed for the project which outlines how you will achieve the required recycling rate, including materials to be recycled or salvaged, materials handling requirements, and how you will communicate the plan to your crews and subcontractors. The waste management plan is to be approved by the OPP Project Leader and submitted with the initial pay application.

At the end of the project, prior to final payment, the contractor is required to submit a calculation documenting that the project achieved a 75% diversion rate. Final payment will be held until this documentation is received. The documentation should include a tabulation of the total waste material, quantities diverted and the means by which diverted. A signature declaring that the requirements have been met must be included.

If the 75% diversion requirement is not met it will be documented on the contractor evaluation and this failure to meet the requirement is grounds for removal from the prequalification list.

If this project is attempting to achieve LEED certification, the LEED process to achieve the Construction Waste Management credit(s) supersedes this section.

ARTICLE 9 - CHANGES IN THE WORK

9.1 CHANGES

Except as provided in this article, no order, oral statement or direction of the Professional or the Owner shall be treated as a Change Order or entitle the Contractor to an adjustment to the Contract Sum and/or the Contract Time.

The Owner, without invalidating the Contract, may order changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, the Contract Sum and the Contract Time being adjusted accordingly. All such changes in the Work shall be authorized by Change Order and shall be performed under the applicable conditions of the Contract Documents. If such changes cause an increase or decrease in the Contractor's cost of, and/or time required for, performance of the Contract, an equitable adjustment shall be made and confirmed in writing in a Change Order.

9.2 CHANGE ORDERS

A Change Order is a written order to the Contractor, signed by the Owner and issued after execution of the Contract, authorizing a change in the Work and/or an adjustment in the Contract Sum and/or the Contract Time. The Contract Sum and the Contract Time may be changed only by Change Order. A Change Order signed by the Contractor indicates the Contractor's agreement therewith, including the adjustment in the Contract Sum and/or the Contract Time.

It is recognized by the parties hereto and agreed by them that the Specifications and Drawings may or may not be complete or free from errors, omissions and imperfections or require changes or additions in order for the Work to be completed in accordance with the Contract Documents and to the satisfaction of Owner and that, accordingly, it is the express intention of the parties, notwithstanding any other provisions in this Contract, that any errors, omissions or imperfections in such Specifications and Drawings or any changes in or additions to same or to the Work ordered by Owner and any resulting delays in the Work or increases in Contractor's costs and expenses, shall not constitute or give rise to
any claim, demand or cause of action of any nature whatsoever in favor of Contractor, whether for breach of contract, quantum meruit, or otherwise; provided, however, that Owner shall be liable to Contractor for the sum stated to be due Contractor in any Change Order approved and signed by both parties, it being agreed hereby that such sum, together with any extension of time contained in said Change Order, shall constitute full compensation to Contractor for all costs, expenses and damages to Contractor, whether direct, consequential or otherwise in any ways incident to, arising out of, or resulting directly or indirectly from the Work performed by Contractor under such Change Order.

9.3 CHANGE ORDER CONTRACT SUM ADJUSTMENTS

Adjustments in the contract price for Work covered by a Change Order shall be computed on the basis of one or more of the following procedures. The Contractor shall have a maximum time of fourteen (14) calendar days to submit change order pricing, unless otherwise directed by the Owner.

9.3.1 Unit Prices: Unit prices as stated in the Contract Documents or subsequently mutually agreed upon by the Owner and the Contractor for the increase or reduction in the Work or portion thereof.

Unit prices shall be inclusive of all costs and shall be applied to units of measure as defined in the Contract Documents for each category of Work.

9.3.2 Lump Sum: A lump sum agreed upon by the Owner and Contractor based on an estimated cost of the increase or reduction in the Work properly itemized and supported by sufficient substantiating data to permit evaluation.

9.3.3 Actual Cost: The actual cost of the Work as determined from job records after the completion of the extra Work. For Work done under this paragraph, the Contractor shall maintain and submit to the Owner for review and approval as directed by the Owner, accurate accounts of all costs and supporting data. There shall be a lump sum cost-not-to-exceed agreed upon by the Owner and Contractor before this provision is used.

9.3.4 Net Cost of Increase or Reduction in the Work: The net cost of the estimated or actual cost of the Work shall be the actual or prorated cost of:

9.3.4.1 Labor at the prevailing rate of wages and fringe benefits.

9.3.4.2 Materials entering permanently into the Work, including delivery to the site.

9.3.4.3 The ownership or rental cost of construction equipment at actual cost, prorated for the time necessary for the Work.

9.3.4.4 Power and consumable supplies for the operation of power equipment at actual cost, prorated for the time necessary for the Work.

9.3.4.5 Insurances and bonds only when supported by paid invoice.

9.3.4.6 When a change in the Work includes a category or categories of Work both added to and deleted from the Contract, the total quantities of added Work and of deleted Work shall be determined separately for each category and the appropriate Unit Price or net cost of the Work shall be the difference between the two total quantities.

9.3.5 Gross Cost of Increase or Reduction in the Work: The gross cost to the Owner for the estimated or the actual cost of the Work performed by the Contractor shall include the net cost of the Work to the Contractor plus an allowance for overhead and profit. The Contractor will be allowed a maximum markup for overhead and profit of 15% on labor only. The Contractor will be allowed a maximum markup for overhead and profit of 10% on material and equipment (not including sales tax). Markup on sales tax is not permitted.

The gross cost to the Owner for the estimated or actual cost of the Work performed by a Subcontractor shall include the net cost of the Work to the Subcontractor plus an allowance for overhead and profit. The Subcontractor will be allowed a maximum markup for
overhead and profit of 15% on labor only. The Subcontractor will be allowed a maximum markup for overhead and profit of 10% on material and equipment (not including sales tax). Markup on sales tax is not permitted. The Contractor will be allowed overhead and profit not to exceed 10% of the Subcontractor's cost.

9.3.6 If no mutual agreement can be reached between the Owner and the Contractor as to the method to complete the Work covered by a Change Order, the change in the Contract Price, if any, shall then be determined on the basis of the reasonable expenditures or savings of those performing, deleting, or revising the Work attributable to the change. In such case, the Contractor shall prepare, in such form and with such contents and details as the Owner requires, an itemized accounting of such expenditures or savings, plus appropriate supporting data for inclusion in a Change Order. Reasonable expenditures or savings shall be limited to the following: reasonable costs of materials, supplies, or equipment, including delivery costs; reasonable costs of labor and fringe benefits required by agreement or custom; reasonable rental or Owner costs of machinery and equipment exclusive of hand tools whether rented from the Contractor or others; actual costs of premiums for all bonds and insurance only when supported by paid invoice specific to change, permit fees, and sales, use, or other taxes related to the Work. In no event shall any expenditure or savings associated with the Contractor's home office or other non-job site overhead expense be included in any change in the Contract Price. Allowance for overhead and profit shall be determined in accordance with Subparagraph 9.3.5.

9.3.7 If a Change Order submission is rejected and the work is considered part of the Contract Price by the Professional and Owner, work shall be considered a claim to the Contract. Pending final resolution of a Claim, unless otherwise agreed in writing, the Contractor shall proceed diligently with performance of the Contract. If the Contractor refuses to complete the work the Owner may proceed in accordance with Subparagraph 8.9.2.

9.3.8 Mark-up for overhead and profit on bond premium increases due to Change Orders is not allowed.

9.4 CHANGE ORDER CONTRACT TIME ADJUSTMENTS

Adjustments in the time required for performance of the Contract for Work covered by a Change Order shall be as agreed upon by the Owner and the Contractor as part of the Change Order. If the parties are unable to agree on the time extension or reduction, the Professional shall make a determination of the time extension or reduction to be allowed for a change.

9.5 MINOR CHANGES IN THE WORK

The Professional, with the Owner's approval, will have authority to order minor changes in the Work not involving an adjustment in the Contract Sum or an extension of the Contract Time. Such changes will be effected by written order which the Contractor shall carry out promptly.

9.6 NOTICE TO SURETY: CONSENT

The Contractor shall notify and obtain the consent and approval of the Contractor's surety with reference to all Change Orders if such notice, consent or approval are required by the Contractor's surety or by law. The Contractor's execution of the Change Order shall constitute the Contractor's warranty to the Owner that the surety has been notified of and consents to such Change Order, and the surety shall be conclusively deemed to have been notified of such Change Order and to have expressly consented thereto.

9.7 EFFECT OF EXECUTED CHANGE ORDER

The execution of a Change Order by the Contractor shall constitute conclusive evidence of the Contractor's agreement to the ordered changes in the Work, this Contract as thus amended, the Contract Price and the Contract Time. The Contractor, by executing the Change Order, waives and forever releases any claim against the Owner for additional time or compensation for matters relating to or arising out of or resulting from the Work included within or affected by the executed Change Order.
ARTICLE 10 - CONTRACT COMPLETION TIME

10.1 NOTICE TO PROCEED

The Contract Time will begin on the date designated in the Notice to Proceed issued by the Owner and the Contractor is required to complete the Work in the time stated therein and in the Agreement.

10.2 PROGRESS AND COMPLETION

Time limits stated in the Contract Documents are of the essence of the Contract. By executing the Agreement the Contractor confirms that the Contract Time is a reasonable period for performing the Work.

The Contractor shall proceed expeditiously with adequate forces and shall achieve Substantial Completion within the Contract Time.

10.3 DELAYS AND EXTENSIONS OF TIME

If the Contractor is delayed at any time in progress of the Work by an act or neglect of the Owner or Professional, or of an employee of either, or of a separate Contractor employed by the Owner, or by changes ordered in the Work, or by labor disputes, fire, unavoidable casualties or other causes beyond the Contractor's control, or by delay authorized by the Owner, or by other causes which the Professional determines may justify delay, then the Contract Time shall be extended by Change Order for such reasonable time as the Professional may determine with the Owner's approval.

Claims relating to time shall be made in accordance with applicable provisions of Subparagraph 7.5.

This Paragraph 10.3 does not preclude recovery of damages for delay by the Owner under other provisions of the Contract Documents.

Apart from extension of time, no payment or claim for damages shall be made to the Contractor as compensation for damages for any ordinary delays or hindrances from any cause whatsoever in the progress of the Work, notwithstanding whether such delay be avoidable or unavoidable.

10.4 COMPLETION AND LIQUIDATION DAMAGES

The Contractor shall substantially complete all of the Work included in the Contract Documents ready for the Owner's use and occupancy, in the Contract Time noted in the Contractor's Form of Proposal and the Agreement subject to extensions of Contract Time as provided in Paragraph 10.3 above. Pursuant to the provisions of Paragraph 10.4, for each calendar day's delay in said completion, the Contractor shall pay to the Owner as liquidated damages, and not as a penalty, the sum in the amount noted in the Project Manual and the Agreement. The Contractor and its surety shall be liable for the amount thereof.

Any delay attributable to lack of coordination or cooperation by or between the Contractor and its Subcontractor(s) will not be recognized by the Owner as the basis for any claim for increase in the Contract Sum or Contract Time.

10.5 SUBSTANTIAL COMPLETION

When the Contractor considers that the Work, or a portion thereof which the Owner wishes or agrees to accept separately, is substantially complete in accordance with Paragraph 1.15, the Contractor shall prepare for submission to the Professional and the Owner a list of items to be completed or corrected. The failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents. When the Professional and the Owner, on the basis of an inspection, determine that the Work is substantially complete, the Professional or Owner will then prepare a Substantial Completion Inspection Report which shall establish the Date of Substantial Completion; shall state the responsibilities of the Owner and the Contractor for maintenance, heat, utilities, operation of permanent equipment, warranty and insurance; and shall fix the time within which the Contractor shall complete the items listed therein. The Substantial Completion Inspection Report shall be submitted to the Contractor as their notification of the responsibilities assigned to each of them.
The Contractor shall be charged with any cost for reinspection resulting from substantial differences between the Contractor’s list of items to be completed or corrected and the list of items resulting from the Professional and Owner’s inspection.

10.6 PARTIAL OCCUPANCY

The Owner may take occupancy or make use of any substantially completed portion of the Work at any stage.

The procedures for the preparation of a list of items to be completed or corrected, Partial Occupancy Inspection and Inspection Reports are to be followed as outlined in Paragraph 10.5 above.

The Contractor agrees that the Owner may place and install as much material, equipment and furnishings as is possible during construction without interfering with orderly progress of the Work and prior to use and occupancy of the various parts of the Work, and further agrees that such placing and installation shall not evidence completion of the Work or signify the Owner’s acceptance of the Work or any part thereof.

Partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

ARTICLE 11 - PAYMENTS AND COMPLETION

11.1 SCHEDULE OF VALUES

Upon execution of the Agreement between the Owner and the Contractor, the Contractor shall submit to the Professional for approval, a breakdown of the Contract price itemizing material and labor for the various classifications of the Work. The breakdown will be used as the basis for the progress payments of the Contract.

The schedule shall be tabulated into subcontracts and trades, for each of which the Quantity, Labor, Material, Other Cost and resulting final Cost per Unit shall be indicated. Labor, Material, Other Cost, Cost per Unit and Quantity generally include but are not necessarily limited to the following:

11.1.1 Quantity: Total number of items for each portion or Unit of Work as determined from the Contract Documents.
11.1.2 Labor: On-site labor required for the handling and installation of material from point of delivery at site.
11.1.3 Material: Cost of material as delivered to site for installation and erection.
11.1.4 Other Costs: Rental equipment, depreciation, site office, administration, overhead and profit, testing, survey and layout, samples and other costs not included in Labor and Material.
11.1.5 Cost per Unit: Total of Labor, Material and Other Cost for each portion or Unit of Work derived from the total Quantity of same.

The Contractor’s monthly application for payment shall reflect the same items as outlined above. Unit costs shall be realistic for their part of the Work.

11.2 APPLICATIONS FOR PAYMENT

Except as otherwise agreed in writing by the parties, and except for any amounts withheld or disallowed due to deficiencies or errors in documentation as defined in Paragraph 11.5 below, payment of progress and final payment applications shall be due from the Owner forty-five (45) days after the end of a billing period or forty-five (45) days after delivery of the Application for Payment, whichever is later.

Within ten (10) calendar days of the effective date hereof, the Contractor shall submit to the Owner and to the Professional a Schedule of Values allocating the Contract Price to the various portions of the Work. The Contractor's Schedule of Values shall be prepared in such form, with such detail, and supported by such data as the Professional or the Owner may require to substantiate its accuracy. The Contractor
shall not imbalance its Schedule of Values nor artificially inflate any element thereof. The violation of this provision by the Contractor shall constitute a material breach of this Contract. The Schedule of Values shall be used only as a basis for the Contractor’s Applications for Payment and shall only constitute such basis after it has been acknowledged in writing by the Professional and the Owner.

Ten (10) days before the date established for each progress payment submittal to the Owner, the Contractor shall submit to the Professional an itemized Application Certificate of Payment for construction activities completed in accordance with the approved Schedule of Values and which shall reflect the appropriate retainage as outlined.

Such application shall be supported by such data substantiating the Contractor’s right to payment as the Owner may require, including weekly payroll certification (Commonwealth of Pennsylvania Department of Labor and Industry form LIPW-126) if applicable.

Such applications may include requests for payment on account of changes in the Work which have been properly authorized by Change Order and fully executed.

Such applications shall not include requests for payment of amounts the Contractor does not intend to pay to a Subcontractor or material supplier because of a dispute or other reason.

The Contractor warrants that title to all Work covered by an Application Certificate of Payment will pass to the Owner at the time of payment. The Contractor further warrants that upon submittal of an Application Certificate of Payment all Work for which Certificates of Payment have been previously issued and payments received from the Owner shall be free and clear of liens, Claims, security interests or encumbrances in favor of the Contractor, Subcontractors, material suppliers, or other persons or entities making a Claim by reason of having provided labor, materials and equipment relating to the Work.

This provision shall not be construed as relieving the Contractor from the sole responsibility for the care and protection of materials and Work upon which payments have been made or the restoration of any damaged Work, or as a waiver of the right of the Owner to require the fulfillment of all of the terms of the Contract.

Payments to the Contractor shall not be construed to release the Contractor or its surety from any obligations under this Contract.

A Certificate of Payment, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

11.3 PAYMENTS FOR STORED MATERIAL

Payments on account of materials or equipment not incorporated in the Work but delivered and suitably stored at the site, or at some other location agreed upon in writing, will be made by the Owner subject to the following conditions:

11.3.1 Such materials or equipment shall have been fabricated or assembled specifically for the Project and delivered to storage no earlier than needed for the orderly progress of the Work as demonstrated by the Progress Schedule.

11.3.2 Title to such materials or equipment shall pass to the Owner pursuant to the Contractor’s bill of sale which shall contain a guarantee of replacement thereof in the event of damage thereto or disappearance thereof due to any cause. Payment by the University for stored material will be made only upon receipt of the Contractor’s paid-in-full invoice from the manufacturer or supplier.

11.3.3 In the case of off-site storage, the Contractor shall also provide consent of Surety to such payment and insurance of such materials or equipment against the perils set forth in Paragraph 3.3, both while in storage and during transportation to the site.

11.3.4 Raw materials or other materials or equipment readily duplicated or usable on other projects will be paid for only after the materials are incorporated into the Project.

11.3.5 Any other documentation as requested by the Owner.

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11.4 CERTIFICATES OF PAYMENT

Based on observations of the Work, the Professional, will either recommend, within seven (7) days (except as otherwise provided in Paragraph 11.5.8 below) after receipt from the Contractor, approval of payment on the Application Certificate of Payment or notify the Contractor and Owner in writing of the Professional's reason(s) for withholding its recommendation in whole or in part as provided in Paragraph 11.5 below.

The Professional shall mark the Certificate of Payment so as to indicate the disapproval of those items for which payment is to be withheld or disallowed and to indicate the corrected values, and shall forward the Certificate of Payment to the Owner for further processing, except that, should the Professional disapprove payment of the entire progress payment, the disapproved Certificate of Payment will be returned to the Contractor, with notification of said return provided to the Owner by the Professional. Approval of the Certificate of Payment shall constitute a representation by the Professional to the Owner that the Work has progressed to the point indicated on the Application, and that to the best of the Professional's knowledge, information and belief, the quality of the Work is in accordance with the Contract Documents.

The foregoing representations are subject to an evaluation of the Work for conformance with the Contract Documents upon Substantial Completion, to results of subsequent tests and inspections, to minor deviations from the Contract Documents correctable prior to completion and to specific qualifications expressed by the Professional. The issuance of a Certificate of Payment will further constitute a representation that the Contractor is entitled to payment in the amount certified. However, the issuance of a Certificate of Payment will not be a representation that the Professional has (1) made exhaustive or continuous on-site inspections to check the quality and quantity of the Work, (2) reviewed construction means, methods, techniques, sequences or procedures, (3) reviewed copies of requisitions received from Subcontractors and material suppliers and other data requested by the Owner to substantiate the Contractor's right to payment or (4) made examination to ascertain how or for what purpose the Contractor has used money previously paid on account of the Contract Sum. Upon Substantial Completion of the Work and upon written request of the Contractor, certification by the Professional and approval of the Owner, retainage for the uncompleted portion of the Work may be reduced to a percentage mutually agreed upon by all parties.

11.5 WITHHOLDING OF PAYMENT

The Professional or the Owner may decline to make payment, may withhold funds, and if necessary, demand the return of some or all of the amounts previously paid to the Contractor or nullify that part of any Application Certificate of Payment to such extent as may be necessary to protect the Owner from loss because of any of the following:

11.5.1 Defective Work not yet remedied by the Contractor or defective work, in the opinion of the Owner, not likely to be remedied by the Contractor.

11.5.2 Third party claims filed or reasonable evidence indicating probable filing of such claims.

11.5.3 Failure of the Contractor to make payments promptly and properly to Subcontractors or others.

11.5.4 Any evidence that the Work cannot be completed for the unpaid balance of the Contract Sum.

11.5.5 Damage to the Owner, another Contractor, or any third party.

11.5.6 Any evidence that the Work will not be completed within the Contract Time, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay.

11.5.7 Failure to carry out the Work in accordance with the Contract Documents.

11.5.8 Errors in Documentation: If a Certificate of Payment is filled out incorrectly or incompletely, or if there is any other defect or improperity in a Certificate of Payment, the Professional or Owner shall give written notice to the Contractor within ten (10) working days after receipt.
of the Certificate, and the Owner shall make payment for the correct amount to the Contractor provided the Certificate of Payment is approved by the Professional in accordance with this Agreement.

11.5.9 Lack of required submissions as outlined in the General Conditions of the Contract.

If the Contractor and Professional cannot agree on a revised amount, the Professional will promptly issue a Certificate of Payment for the amount which the Professional is able to recommend to the Owner.

When the above reason(s) for withholding recommendation or nullifying any part of a Certificate of Payment are removed, recommendation and payment will be made for amounts previously withheld.

11.6 PAYMENTS TO SUBCONTRACTORS

Upon receipt of payment from the Owner, the Contractor shall promptly pay each Subcontractor, out of the amount paid to the Contractor the amount to which said Subcontractor is entitled, reflecting percentages actually retained from payments to the Contractor on account of such Subcontractor’s portion of the Work. The Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor to make payments to Sub-subcontractors in similar manner.

The Professional or Owner will, on request, furnish to a Subcontractor, if practicable, information regarding percentages of completion or amounts applied for by the Contractor and action taken thereon by the Professional and Owner on account of portions of the Work done by such Subcontractor.

Neither the Owner nor Professional shall have an obligation to pay or to see to the payment of money to a Subcontractor.

Payment to material suppliers by the Contractor shall be treated in a manner similar to that provided above.

11.7 FAILURE OF PAYMENT

If the Professional does not recommend approval of payment, through no fault of the Contractor, within fourteen (14) days after receipt of the Contractor’s Application of Payment, or if the Owner does not pay the Contractor within a reasonable time the amount certified by the Professional, then the Contractor may, upon seven (7) additional days’ written notice to the Owner and Professional, stop the Work until payment of the amount owing has been received. The Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor’s reasonable costs of shutdown, delay and start-up, which shall be accomplished as provided in Article 9.

11.8 FINAL COMPLETION AND FINAL PAYMENT

11.8.1 Notification: When the Work is completed, the Contractor shall notify the Professional and Owner in writing that the Work will be ready for final inspection on a definite date. Upon verification by the Professional that the Work is ready for final inspection and acceptance, the Professional and Owner will make a final inspection and, when the Work is found acceptable under the Contract Documents and the Contract is fully performed, the Owner will make final payment to the Contractor.

11.8.2 Final Payment Documentation: The final payment for the remaining retained percentage shall not become due until the Contractor submits to the Professional for transmittal to the Owner (1) an affidavit that all payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or the Owner’s property might in any way be responsible, have been paid or will be paid or otherwise satisfied within thirty (30) days after receipt of final payment from the Owner, (2) consent of surety to final payment, (3) Certificate of Completion and Release of Liens, (4) MBE/WBE participation data, (5) OSHA recordable accident data, (6) construction waste management documentation, and (7) all maintenance manuals, as-built drawings and warranty certificates that may be required. If any third party fails or refuses to provide a release of claim or waiver of lien as required by Owner, the Contractor shall furnish a bond satisfactory to the Owner to indemnify the Owner from liability.
11.8.3 Final Payment: Acceptance of final payment by the Contractor shall constitute a waiver of all claims by the Contractor except those specifically enumerated in writing previously and identified in writing as unsettled at the time of final payment.

The making of final payment shall constitute a waiver of claims by the Owner except those arising from any of the following:

11.8.3.A Liens, Claims, security interests or encumbrances arising out of the Contract and unsettled.

11.8.3.B Failure of the Work to comply with the requirements of the Contract Documents.

11.8.3.C Terms of special warranties required by the Contract Documents.

ARTICLE 12 - CONTRACT WARRANTY PERIOD

12.1 WARRANTY

Except as otherwise specified, the Contractor warrants and guarantees all Work against defects in materials, equipment and/or workmanship for a period of one (1) year from the date of Substantial Completion of the entire Project or Partial Occupancy of any portion thereof and for that period of time noted in any special or extended warranty.

This period of one (1) year shall be extended with respect to portions of the Work first performed after Substantial Completion by the period of time between Substantial Completion and the actual performance of the Work.

If building commissioning work is not complete at the time of substantial completion, the warranty period for all related building systems may be extended by the Owner. Documentation by the Owner shall be submitted at the time of substantial completion indicating the building systems not yet properly commissioned. Once the building systems have been completed to the satisfaction of the Owner, a letter will be issued by the Owner indicating the listing of building systems and equipment with the revised warranty period. The Contractor’s warranty excludes remedy for damage or defect caused by abuse, modifications not executed by the Contractor, Improper or insufficient maintenance, improper operation or normal wear and tear under normal usage.

This warranty and guarantee is not the exclusive remedy of the Owner but is in addition to the general obligation of the Contractor to faithfully perform the Contract, and it in no way limits the responsibility of the Contractor for faulty materials or workmanship.

12.2 CORRECTION OF DEFECTS

Upon receipt of written or verbal notice from the Owner or Professional of the discovery of any defects in materials, equipment and/or workmanship, the Contractor shall remedy the defects and replace any property damaged therefrom occurring within the warranty and guarantee period. Any defects discovered in materials, equipment and/or workmanship which are included in any manufacturer’s written warranty certificate shall be remedied in accordance with the manufacturer’s recommendations and procedures.

If any of the Work is found to be not in accordance with the requirements of the Contract Documents, including substitutions not properly approved and authorized, such Work will be considered defective and shall be corrected promptly by the Contractor after receipt of notice from the Owner or Professional.

If the Contractor, after notice, fails to proceed promptly and remedy such defects within thirty (30) days or within another period of time which has been agreed to in writing, in compliance with the terms of the warranty and guarantee, the Owner may have the defects corrected and the Contractor and its surety shall be liable for all expenses incurred.

12.3 ONE-YEAR INSPECTION

Prior to the expiration of the one (1) year guarantee period against defective materials, equipment and/or workmanship, the Professional and Owner shall conduct an inspection to determine any other defects in
material, equipment and/or workmanship not previously noticed and corrected as outlined in Paragraph 12.2 above.

Should any additional defects be discovered, the Contractor, upon receipt of written notice from the Professional or Owner, shall promptly remedy the defects and replace any property damaged therefrom.

If the Contractor, after notice, fails to proceed promptly and remedy such defects within thirty (30) days or within another period of time which has been agreed to in writing, in compliance with the terms of the warranty and guarantee, the Owner may have the defects corrected and the Contractor and its surety shall be liable for all expenses incurred.

ARTICLE 13 - EQUAL EMPLOYMENT OPPORTUNITY

13.1 NON-DISCRIMINATION CLAUSE

During the term of this Contract, Contractor agrees as follows:

13.1.1 Contractor shall not discriminate against any applicant for employment or any independent Contractor or any other person because of race, color, religious creed, ancestry, national origin, age, or sex. Contractor shall not discriminate against any employee or independent Contractor or other person because of race, color, religious creed, ancestry, national origin, age, or sex.

Contractor shall take affirmative action to ensure that applicants are employed, and that employees or agents are treated during employment, without regard to their race, color, religious creed, ancestry, national origin, age, or sex. Such affirmative action shall include, but is not limited to, the following: Employment upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training.

Contractor shall post in conspicuous places, available to employees, agents, applicants for employment and other persons, notices to be provided by the contracting agency setting forth the provisions of this non-discrimination clause.

13.1.2 Contractor shall in solicitations or advertisements placed by it or on its behalf state all qualified applicants will receive consideration for employment without regard to race, color, religious creed, ancestry, national origin, age, or sex.

13.1.3 Contractor shall send each labor union or workers’ representative with which it has a collective bargaining agreement or other contract or understanding, a notice advising said labor union or workers’ representative of its commitment to this non-discrimination clause and shall post copies of the notice in conspicuous places available to employees and applicants for employment. Similar notices shall be sent to every other source of recruitment utilized by Contractor.

13.1.4 It shall be no defense to a finding of a non-compliance with Executive Order 1972-1 or any regulations issued by the Pennsylvania Human Relations Commission or this non-discrimination clause that recipient had delegated some of its employment practices to any union, training program or other source of recruitment which prevents it from meeting its obligations.

13.1.5 Where the practices of a union or any training program or other source of recruitment will result in the exclusion of minority group persons, so that Contractor will be unable to meet its obligations under Executive Order 1972-1 or any regulations issued by the Pennsylvania Human Relations Commission or this non-discrimination clause, the Contractor shall then employ and fill vacancies through other employment procedures without regard to race, color, religious creed, ancestry, national origin, sex, or age, taking affirmative action to obtain qualified minority group persons.

13.1.6 Contractor shall comply with all rules, regulations and orders issued by the Governor, the Attorney General, and the Human Relations Commission relating to laws, prohibiting discrimination in hiring or employment opportunities. In the event of Contractor’s non-compliance with the non-discrimination clause of this Contract or with any such rules, regulations or orders, this Contract may be cancelled, terminated or suspended in whole or
in part, and recipient may be declared ineligible for further Commonwealth contracts, and such other sanctions may be imposed and remedies invoked as provided by rule, regulation or order of the Governor, Attorney General, or the Human Relations Commission, or as otherwise provided by law.

13.1.7 Contractor shall furnish all information and reports required by the Governor, Attorney General, and the Human Relations Commission and will permit access to its books, records and accounts by the contracting agency and the Human Relations Commission, for purposes of investigation to ascertain compliance with provisions of Executive Order 1972-1 or any regulations issued by the Pennsylvania Human Relations Commission or this non-discrimination clause.

13.1.8 Contractor shall actively recruit minority Subcontractors or Subcontractors with substantial minority representation among their employees.

13.1.9 Contractor shall include the provisions of Paragraphs 13.1.1 through 13.1.10 in every Subcontract or Purchase Order, so that such provisions will be binding upon each Subcontractor or vendor or other person.

13.1.10 The terms used in this non-discrimination clause shall have the same meaning as in the Contract Compliance Regulations issued by the Pennsylvania Human Relations Commission, 16 Pa. Code Ch. 49.

ARTICLE 14 - MISCELLANEOUS PROVISIONS

14.1 RIGHTS AND REMEDIES

Duties and obligations imposed by the Contract Documents and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights and remedies otherwise imposed or available by law.

No actions or failure to act by the Owner, Professional or Contractor shall constitute a waiver of a right or duty afforded them under the Contract, nor shall such action or failure to act constitute approval of or acquiescence in a breach thereunder, except as may be specifically agreed in writing.

14.2 INDEMNIFICATION

To the fullest extent permitted by law, the Contractor shall appear for and defend, indemnify, and hold harmless the Owner, Professional, Professional's consultants, and agents and employees of any of them from and against claims, damages, losses, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work, of whatsoever nature caused in whole or in part by the Contractor, a Subcontractor, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss, or expense is caused in part by a party indemnified hereunder. Such obligation shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity which would otherwise exist as to a party or person described in this Paragraph 14.2.

In claims against any person or entity indemnified under this Paragraph 14.2 by an employee of the Contractor, a Subcontractor, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, the Indemnification obligation under this Paragraph 14.2 shall not be limited by a limitation on amount or type of damages, compensation or benefits payment by or for the Contractor or a Subcontractor under workers' or workmen's compensation acts, disability benefit acts or other employee benefit acts.

The obligations of the Contractor under this Paragraph 14.2 shall not extend to the liability of the Professional, the Professional's consultants, and agents and employees of any of them arising out of (1) the preparation or approval of maps, drawings, opinions, reports, surveys, Change Orders, designs or specifications, or (2) the giving of or the failure to give directions or instructions by the Professional, the Professional's consultants, and agents and employees of any of them, provided such giving or failure to give is the primary cause of the injury or damage.

The status of the Contractor in the Work to be performed by it under this Contract is that of an Independent Contractor and as such the Contractor shall properly safeguard against any and all personal
injury including death, or damage to the public, to public and private property, materials, and things; and as such, the Contractor alone shall be responsible for any and all damage, loss, or injury to persons or property that may arise or be incurred in or during the conduct or progress of said Work without regard to whether or not the Contractor, its Subcontractors, Agents, or Employees have been negligent; and the Contractor shall keep the Owner and Professional indemnified from and discharged of and from any and all responsibility and liability for risks and casualties of every description, as provided in the Agreement between the Owner and the Contractor.

GENERAL CONDITIONS OF THE CONTRACT: JANUARY 2009
SECTION D1
NOTIFICATION OF CONTRACT REQUIREMENTS PERTAINING TO THE PREVAILING WAGE ACT

1. The Contractor shall pay no less than the wage rates as determined in the decision of the Secretary of Labor and Industry and shall comply with the conditions of the Pennsylvania Prevailing Wage Act approved August 15, 1961 (Act No. 442), as amended August 9, 1963 (Act No. 342), and the Regulations issued pursuant thereto, to assure the full and proper payment of said rates.

2. Such workmen shall be paid no less than such general prevailing minimum wage rates and such other provisions to assure payment thereof as heretofore set forth in this Section.

3. The Contract provisions shall apply to all work performed on the Contract by the Contractor and to all work performed on the Contract by all Subcontractors.

4. The Contractor shall insert in each of its subcontracts all of the stipulations contained in these required provisions and such other stipulations as may be required.

5. No workmen may be employed on the public work except in accordance with the classifications set forth in the decisions of the Secretary. In the event that additional or different classifications are necessary, the procedure set forth in Section 7 of these Regulations shall be followed.

6. All workmen employed or working on the public work shall be paid unconditionally, regardless of whether any contractual relationship exists or the nature of any Contractor, Subcontractor and workmen, not less than once a week without deduction or rebate, on any account, either directly or indirectly, except authorized deductions, the full amounts due at the time of payment, computed at the rates applicable to the time worked in the appropriate classification. Nothing in the Contract, the Act, or these Regulations shall prohibit the payment of more than the general prevailing minimum wage rates as determined by the Secretary to any workman on public work.

7. The Contractor and each Subcontractor shall post for the entire period of construction the wage determination decisions of the Secretary, including the effective date of any changes thereof, in a prominent and easily accessible place or places at the site of the work and at such a place or places used by them to pay workmen their wages. The posted notice of wage rates must contain the following information:
   a. Name of project.
   b. Name of public body of which it is being constructed.
   c. The crafts and classifications of workmen listed in the Secretary's general prevailing minimum wage rate determinations for the particular project.
   d. The general prevailing minimum wage rates determined for each craft and classification and the effective date of any changes.
   e. A statement advising workmen that if they have been paid less than the general prevailing minimum wage rate for their job classification or that the Contractor and/or Subcontractor are not complying with the Act or these Regulations in any manner whatsoever, they may file a protest with the Secretary of Labor and Industry. Any workmen paid less than the rate specified in the Contract shall have a civil right of action for the difference between the wage paid and the wages stipulated in the Contract, which right of action must be exercised within six (6) months from the occurrence of the event creating such right.
8. The Contractor and all Subcontractors shall keep an accurate record showing the name, craft and/or classification, number of hours worked per day, and the actual hourly rate of wage paid (including employee benefits) to each workman employed by him in connection with the public work, and such record must include any deductions from each workman. The record shall be preserved for two years from the date of payment and shall be open at all reasonable hours to the inspection of the public body awarding the contract and to the Secretary or his duly authorized representative.

9. Apprentices shall be limited to such numbers as shall be in accordance with a bona fide apprenticeship program registered with and approved by the Pennsylvania Apprenticeship and Training Council, and only apprentices whose training and employment are in full compliance with the provisions of the Apprenticeship and Training Act approved July 14, 1961 (Act No. 304), and the Rules and Regulations issued pursuant thereto shall be employed on the public work project. Any workman using the tools of a craft who does not qualify as an apprentice within the provisions of this Subsection shall be paid the rate predetermined for journeymen in that particular craft and/or classification.

10. Wages shall be paid without any deductions except authorized deductions. Employers not parties to a contract requiring contributions for employee benefits which the Secretary has determined to be included in the general prevailing minimum wage rate shall pay the monetary equivalent thereof directly to the workmen.

11. Payment of compensation to workmen for work performed on public work on a lump-sum basis, or a piecework system, or a price certain for the completion of a certain amount of work, or the production of a certain result shall be deemed a violation of the Act and these Regulations, regardless of the average hourly earnings resulting therefrom.

12. Each Contractor and each Subcontractor shall file a statement each week and a final statement at the conclusion of the work on the Contract with the contracting agency, under oath, and in form satisfactory to the Secretary, certifying that all workmen have been paid wages in strict conformity with the provisions and if any wages remain unpaid to set forth the amount of wages due and owing to each workman respectively.

13. The provisions of the Act and these Regulations shall be incorporated by reference in the Contract.
PREVAILING WAGES PROJECT RATES

**Project Name:** Henderson Bridge Replacement Building

**Awarding Agency:** Penn State University

**Contract Award Date:** 11/8/2010

**Serial Number:** 10-06075

**Project Classification:** Building

**Determination Date:** 9/9/2010

**Assigned Field Office:** Altoona

**Field Office Phone Number:** 814-840-6224

**Toll Free Phone Number:**

### Centre County

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## PREVAILING WAGES PROJECT RATES

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TAX INFORMATION

Per the PA Sales and Use Tax Regulation 150 (61 Pa Code SS31.11-SS31.16), Contractor is not required to pay sales tax or use tax on “building machinery and equipment” (or services to such property) which is transferred to The Pennsylvania State University an exempt entity, under this contract.

- Air Handling Units
- Fans
- HVAC Controls- Head End and Devices
- Fire Alarm System
- Chillers
- Boilers
- Grilles, Registers and Diffusers
- Dampers and Actuators
- Plumbing Fixtures
- Pumps
- Electrical Switchgear
- Electrical Panel boards
- Lighting Fixtures
- Fire Alarm- Head End and Devices
- Communication Equipment
- Public Affairs Equipment
- Casework and Furniture
- Louvers

Building machinery and equipment includes: boilers, chillers, air cleaners, humidifiers, fans, switch gear, pumps, telephones, speakers, horns, motion detectors, dampers, actuators, grills, registers, traffic signals, sensors, card access devices, guard rails, medical devices, floor troughs and grates, and laundry equipment together with integral coverings and enclosures. The term does not include guard rail posts, pipes, fittings, pipe supports and hangers, underground tanks, wire, conduit receptacles and junction boxes, insulation, duct work and coverings thereof.

Note: The above listing is to be used for informational purposes only. For specific determinations, contractors are encouraged to contact the Pennsylvania Department of Revenue directly.

The Pennsylvania State University will provide the appropriate documentation upon request for those building machinery and equipment items as listed above that are applicable to this contract and no sales or use tax is due on those items. Contractor, however, must pay sales tax when it purchases all other materials in this contract.

Pennsylvania Act 1998-45
71).S.p7201(pp)

END OF TAX INFORMATION

TAX EXEMPTION INFORMATION
Section E

THE PENNSYLVANIA STATE UNIVERSITY

HENDERSON ADDITION – BIOBEHAVIORAL HEALTH BUILDING

DGS Project Number 800-290
PSU Project Number 06-42744

DRAWING LIST
## VOLUME I:  CIVIL - LANDSCAPE

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SECTION F [C]

GENERAL CONDUCT OF THE WORK AND SPECIAL REQUIREMENTS

General Project Description

The construction of a new 4 story (plus ground floor below grade) 93,915+/- SF mixed used office/classroom building. Construction is anticipated to occur over the duration of 22-23 months starting December 2010 to October 2012. This project includes the construction of a new 4 story (plus ground floor below grade) 93,915+/- SF mixed used office/classroom building, an underground lecture hall with a lawn terrace above, site work, demolition and abatement of the existing Henderson Bridge Building.

Construction features include cast in place basement walls, structural steel slab-on deck, brick/stone exterior, slate and vegetative roofing systems and curtain wall and storefront systems.

General Project Organization

OWNER: The Pennsylvania State University

ARCHITECT: Bohlin Cywinski Jackson

CONSTRUCTION MANAGER: Massaro CM Services, LLC

CONTRACTORS: The project is organized into the following bid packages and it is intended that prime contracts will be issued for these activities.

- Hazardous Material Abatement 800-290.HA1.1
- Demolition 800-290.BD2.1
- General Trades Work 800-290.GC3.1
- Fire Protection 800-290.5
- Plumbing 800-290.3
- HVAC 800-290.2
- Electrical 800-290.EL1.4
- Telecommunications 800-290.TL2.4
- Landscaping 800-290.LA4.1

Bids shall be based on any one of the specified products. Bidders shall not use a product contemplated for substitution to establish bidder's bid proposal price. Where one product only is named, such designation has been made in order to match existing products exactly or to otherwise suit the Owner's purposes.

The Construction Manager shall be responsible for the overall coordination process, control of the site, sequence of work and monitoring the progress of the work for all of the other Prime Contractors, Subcontractors and material suppliers involved in the project.

F-01 General

A. This section contains special instructions relating to the execution of the work shown on the drawings and required by the specifications, and is applicable to all Contracts.

B. Each Prime Contractor is required to provide a full time safety person/competent person on site trained to the level of achieving OSHA 30 hour certification. All
other supervision (project manager, engineers, superintendents and foremen) should be trained to a minimum level of OSHA 10 hour certification.

C. The project will have one construction entrance that will be paved from College Avenue to the main jobsite gate. It will be the responsibility of the General Trades prime contractor to clean and maintain the entrance road and entrance area at all times, this entrance may be shut down at any time by the construction manager if compliance is not maintained. Maintenance includes but is not necessarily limited to; snow removal, construction debris removal and general trash removal. (See attached Site Logistics Plan.)

D. A full time flagger employed by the Construction Manager will be stationed at the gate nearest College Avenue for pedestrian safety, traffic control and delivery verification and coordination.

E. Site access via truck will be limited to an overall height of 14’-0”.

F. Due to space and logistics limitations, only fully loaded trailer trucks will be allowed to enter the job site. Partial deliveries should be route through each Prime Contractor’s shop and delivered by smaller stake bed and pick-up trucks.

G. The construction entrance will include a truck/tire wash station to limit/eliminate all mud and debris on adjacent roadways. The wash station will be provided and maintained by the General Trades prime contractor for the project duration.

H. The Construction Manager will install, the site perimeter fence (as detailed on site logistics plan, fence fabric, initial tree protection, temporary walks, temporary construction road, and a stone base over fabric on all areas inside the construction fence and outside the building footprint/shored area. It is the responsibility of each Prime Contractor to maintain/replace to original the stone base/fabric after any excavation inside the construction fence.

I. It will be the responsibility of each Prime Contractor to backfill/replace (to original condition)/maintain/clean any site condition (concrete, asphalt, grass, landscaping, etc) disturbed during any work that takes place outside the construction fence. Daily cleaning is required. All necessary pedestrian or vehicle detour signage is the responsibility of the Prime Contractor doing the work and must be coordinated with Construction Manager and PSU.

J. All construction activity including demolition and hauling will occur during defined work periods. In general this work period starts at 7:00AM and concludes at 3:30PM. No workers or trades personnel will be permitted on site ½ hour prior to normal work periods or longer than ½ hour after normal work periods. Construction activity outside the normal work periods must be approved by the Construction Manager with a minimum of 48 hours notice.

K. Erosion and sedimentation will be governed by the NPDES permit submission. Comprehensive Erosion and Sediment Control documents are included in the construction documents and as such will be the responsibility of the General Trades Contractor to install and the General Trades Contractor to maintain. The General Trades Contractor will be a co-permittee to the NPDES Permit. All regulations required by the NPDES permit will be strictly enforced. These regulations control all construction activities and their potential impact on air and water quality and the containment of all sediment within the boundaries of the construction site.

L. It is the responsibility of each Prime Contractor to make sure their employees and subcontractors understand all job site rules and safety procedures and come to the
site prepared to complete their scheduled work with clear direction from the Prime Contractor on the scope of work to be performed, schedule, current drawings, specifications and sketches.

F-02 Definitions

A. Wherever the Contract Documents contain the terms “work,” “building,” “structure,” “project,” or words like import are used, it shall be understood to refer to and designate all construction materials and labor, complete and ready for use, within the limits of the contract lines as shown on the plot plan and specified.

B. “Provide” as used in the specification documents shall be understood to mean furnish and install complete and ready for use.

F-03 Project Coordination

A. The Construction Manager shall be responsible for the overall coordination, control, and progress of the work for all of the other Prime Contractors, Subcontractors, and material suppliers involved in the project.

B. The General Trades Contractor shall be responsible for preparing the progress schedule indicating the sequence and time required for the varied disciplines of the work. The progress schedule shall be submitted by the General Trades Contractor to the other Prime Contractors requesting their sequence and time requirement input. The Prime Contractors will be required to either approve the progress schedule submitted by the General Trades Contractor or give comments for correction.

After approval by all Prime Contractors, one progress schedule showing all disciplines shall be prepared. The completed progress schedule shall then be submitted to the Contraction Manager and Professional for review and approval. The approved progress schedule shall then be issued by the General Trades Contractor to all Prime Contractors, the Professional, and the University.

F-04 Project Meetings

A. Preconstruction Conference. Prior to commencement of the work, the Contractors shall meet in conference with representatives of the Owner and the Construction Manager, to discuss and develop mutual understanding, relative to administration of the project, general conduct of the work, progress schedules, safety programs, labor provisions, and other contract procedures relating to the work.

B. The Construction Manager shall provide a space to conduct a regularly scheduled, biweekly (every two weeks) meeting at the site for the purpose of coordinating the work. The Construction Manager shall require representation from all Prime Contractors and by any Subcontractors upon request of the Professional or the University.

C. Contractors shall attend personally or be represented at such meetings. Should the Contractor elect to be represented, it shall be understood and agreed that the University and the Professional, in dealing with contractor's representatives, do so with full assurance that such representative's actions and commitments may be accepted the same as though the contractor who signed, and is bound by the contract, were itself present and personally made such agreements or commitments.
D. The Professional shall take and retain a verbatim record of the biweekly meeting and shall prepare and distribute summary minutes of each meeting within four (4) days to the University, the Contractors, and all other interested parties. Any corrections to the minutes are to be sent to the Professional within four (4) working days after receipt of same.

E. Job meetings will be held at a predetermined day and time each week at the jobsite. Any and all coordination and schedule related issues will be discussed in these meetings. The Project Manager and superintendent/foreman of each company must attend these meetings regardless of the size of his crew on the project at that time.

F. Each superintendent will provide a two-week look-ahead schedule for review and coordination at the meeting. The schedule will show all activities individually, with start/end dates, show the activities critical path based on the overall schedule, and the activities durations in days.

G. In addition to weekly Construction Manager/Prime Contractor coordination meetings there will be bi-weekly CM/Owner/Architect meetings.

F-05 Order of Work

A. If in the judgment of the University, it becomes necessary at any time during construction to expedite the work or any part of it to conform with the approved project schedule, the Contractor shall cease work at any location, transfer its men to other locations, and execute other portions of the work as may be directed.

F-06 Parking for Contractors' Employees

A. Parking for one vehicle for each Prime Contractor will be provided at a designated area in the vicinity of the project site. The parking fee for these vehicles shall be established by the University's Parking Office. Each Contractor is advised to contact the Parking Office at (814) 865-1436 for rate information.

B. Parking for all other Contractor vehicles (either company-owned or employee-owned) will be provided in a parking lot designated by the University. The parking fee for these vehicles shall be established by the University's Parking Office. Each Contractor is advised to contact the Parking Office at (814) 865-1436 for rate information.

C. It will be each Contractor's responsibility to inform its employees that they cannot park at any location on the campus other than the assigned area. All existing University parking regulations shall be enforced.

D. Each Contractor shall arrange for transportation between the assigned parking area and the project site.

F-07 Unclassified Excavation

A. All excavation work will be unclassified and will include (without limitation thereto) the excavation and removal of all soil, shale, rock or rock formations, boulders, existing foundations, fill, and any type of subsurface condition encountered.

B. The University will consider no claims for extra compensation or extension of time because of the nature and subsurface conditions encountered.
F-08 Blasting

A. Because of experimental work being done in certain buildings on the campus and because laboratory equipment can be damaged or destroyed by unexpected vibrations due to blasting operations, it will be necessary for the Contractor doing blasting to conform to an established procedure which is in effect on the campus. It is not anticipated that blasting will be required on this project; however, should this event occur, the procedure will be made available to the Contractor.

F-09 Protection of Property

A. Protect all trees, shrubs, lawn areas, curbing, walks, roadways, and ground areas from damage during the course of the construction. Protect the existing structures and Contractors shall use care in the work in general in, on, and around the structures. Repair all damage to the satisfaction of the University at the responsible party's cost and expense.

F-10 Warning Lights

A. Where warning lights are required, they shall be the blinker type, battery or electrically operated. Open-flame-type torches are not permitted.

F-11 Access

A. Each Contractor shall maintain unobstructed pedestrian and automobile traffic lanes on the campus roads, service drives, and parking areas.

B. Protect existing buildings and structures from damage. Take all precautions to avoid damaging utilities.

C. The General Trades Contractor shall cover all stairs, treads, and risers, immediately after erection with heavy building paper, on top of which shall be placed boards, securely fastened in place, until project completion.

D. Each Contractor shall provide constant protection against rain, wind, storms, frost, or heat so as to maintain his work, materials, apparatus, and fixtures free from damage. At the end of each day's work, cover work likely to be damaged. During cold weather, protect work from damage by freezing and provide such enclosures and heating apparatus as may be necessary to prosecute the work without stoppage for reason of unfavorable weather.

E. Each Contractor, in all areas of operations, shall provide barricades, guard lights, and other appurtenances for the protection of workmen and public as required by applicable regulations and for the protection of roads, lighting, hydrants, walks, curbs, and adjacent grounds and planting for the duration of such operations. The Contractor shall bear the costs of damage caused by it and/or its Subcontractors.

F-12 Construction Fence

A. The Construction Manager will provide a construction fence enclosing the area of the work within the central limits. Construction fencing is also required for trailers and stored material that may be located outside the area of work. Fencing material should be adequate to protect persons and property.
1. Provide a six foot high (6') chain-link fence with galvanized frame and fabric, and adequate gates as required. Posts shall be 2 inch dia and spaced at maximum of 8 feet OC. Anchor posts in concrete footing. Footing shall be 10 inch diameter, with bottom at 36 inches below grade. Place tops of footing 3 inches below grade and cover with soil. Embed posts 24 inches in concrete. Provide top stabilizing rail between posts. Top of posts shall be closed.

2. Provide 5’–6” mesh fabric windscreen, mount top of fabric to top stabilizing bar. Fabric shall be PVC vinyl coated polyester, equal to Tenn-air curtain style, color US Open blue as manufactured by M. Putterman and Co., Inc. (800) 621-0146. Windscreen shall have reinforced hems and grommets every 12 inches on all edges. Install windscreen on construction side of fence, using 50-pound break strength tie wraps at every grommet. Pull fabric taught. (Optional: Penn State Logo shall be imprinted on windscreen facing the non-construction side of the fence at the request of the Project Manager.)

F-13  Temporary Facilities

A.  **Offices.** Contractor’s may erect a temporary office where directed. It shall be adequate in size for conducting the work. Size, quantity and location must be coordinated with the Construction Manager.

B.  **Sheds.** Contractor’s may provide and erect temporary sheds, as directed, for the storage of tools, equipment, and materials. Size, quantity and location must be coordinated with the Construction Manager.

C.  **Toilets.** The General Trades Contractor shall provide, erect, and maintain adequate toilet facilities for all Prime Contractors for the convenience of workmen and others employed on the work. The University and Construction Manager shall approve the type of facility and location. Toilet facilities maintenance should be completed twice a week for the duration of the project.

D.  **Scaffolding and Staging.** The Contractor shall furnish and erect all ladders, staging, and scaffolding required.

E.  **Design.** The University shall approve the design and appearance of offices, sheds, and toilets prior to erection.

F.  **Removal.** Prior to completion of the work, the Contractors shall completely remove the temporary buildings, offices, sheds, toilets, scaffolding, etc., and all other items of temporary facilities and construction provided by them, and restore the area to the original condition acceptable to the University.

G.  **Jobsite Hoisting:**
All hoisting of materials required for the performance of work shall be by each contractor. Install and operate in accordance with all safety regulations of authorities having jurisdiction. Use of crane lifts over any occupied building or area, or the general public is prohibited.

F-14  Existing Underground Utilities

A.  The existence and locations of underground utilities indicated on the drawings are not guaranteed. The Contractor shall investigate and verify in the field before starting any work.
B. All excavation within three (3) feet of any existing underground utility line shall be accomplished by hand labor. Extreme caution shall be used in this area to prevent any damage to existing facilities.

C. The Contractor shall adequately protect from damage (including shoring, if necessary), all underground utilities uncovered or exposed. The Contractor shall be responsible for all damage to existing underground utilities caused by its work and shall repair by a method approved by the University.

D. Utilities serving existing buildings, installation, or facilities shall not be interrupted until the Contractor has made the necessary arrangements with and has received approval from the University.

E. In the event that interruption of any existing utility service is necessary, the responsible Contractor shall be required to make all arrangements for shutdown and start-up of such service with the University representative.

F-15 Temporary Utility Services

A. Each Contractor shall, at its own cost and expense, install, operate, protect, and maintain the respective temporary services as hereinafter specified, during the construction period of the entire project. These temporary services shall include water supply, electric light and power, temporary heat, material hoists, sanitary facilities, access roads, and any other services as may be stipulated in the General Conditions, Special Requirements, and/or specifications.

B. Temporary or permanent connections made by any Contractor to existing University systems shall be approved by the University, as to location and the manner and time of the connections to such systems. Where such connections require shutdown of an existing University system, at the University Park Campus the shutdown will be made by University personnel. At other locations, the shutdown will be performed by the Contractor. A written advance notice of at least fourteen (14) days shall be given to the University by the Contractor requesting the shutdown. Directly after the final connection by the Contractor, at the University Park Campus, reinstatement of the service shall be performed by University personnel. At other locations, reinstatement will be done by the Contractor.

C. Temporary connections to new and/or existing permanent service lines shall be made at locations as directed by the University, protected while in use, and when the temporary service lines are no longer required, they shall be removed by the Contractor. Any part or parts of the permanent service lines, grounds, and buildings, disturbed or damaged by the installation and/or removal of the temporary service lines shall be restored to their original condition by the Contractor responsible for the temporary installation, by a method approved by the University.

D. At the University Park Campus, University personnel must be used to shut down and start up all University services which require interruption for temporary or permanent connections. All underground utilities or service lines uncovered or exposed by the operations under this contract shall be adequately protected by the Contractor, who shall be responsible for the repair of any damage to such services. Services and utilities in and to existing buildings must not be connected to or interrupted without making the necessary written requests to the University and receiving written permission. All interruptions to University services must be scheduled two (2) weeks in advance and will generally be made outside of normal working hours.
E. The General Contractor shall pay all costs for water, electric power, and fuel required for the operation of temporary services.

F. Any Contractor who fails to carry out its responsibility in supplying temporary services, as set forth in its contract, shall be held responsible for such failure and the University shall have the right to take such action as it deems proper for the protection and conduct of the work and shall deduct the cost involved from the amount due the Contractor.

G. All services furnished by the University will be metered by meters furnished by the respective Contractors. The services will be charged at the verified current rates.

1. Prior to a Contractor's use of steam, electricity, or water from the University's distribution systems, a meter shall be installed by the Contractor to measure the consumption.

   a. In the case of steam, condensate shall not be wasted and shall be returned to the University system.

2. When meters are installed at the University Park Campus, metering connections will be inspected and readings obtained by the University prior to any usage and periodically thereafter until the Contractor's liability for this cost ends.

   Piping for all condensate and water meters shall include all valving and hose bibs necessary to permit field checks of those meters, as well as confirm to any other requirements as might be imposed by these specifications.

3. At the University Park Campus, the University shall be notified when any meter is removed or disconnected, for any reason during this period of Contractor liability. A record shall be maintained by the Contractor relative to the length of time such meters are inoperable. If other meters are installed permanently or temporarily to replace existing meters, meter readings and serial numbers shall be recorded, appropriate record changes made, and the University's designated representative notified.

4. Reasonable access to all metering in the Contractor's area shall be provided for inspection of meter connections and periodic meter reading by the University.

H. Temporary Water Supply

1. The Plumbing Contractor shall, at its own cost and expense, install, meter, operate, protect, and maintain an adequate water supply for the use of all Contractors on the project during the period of construction, either by means of the permanent water supply or by the installation of a temporary water supply line. This water supply line shall be made available within fifteen (15) days after being so directed by the University. All Contractors shall notify the University twenty (20) days prior to the time that they will require water supply.

2. The Plumbing Contractor will be required to bring the temporary water supply to a point approximately ten (10) feet from the building. The actual location of the point to which the water is brought shall be in close proximity to the point of entrance of the permanent water supply. From this point each Contractor shall install, valve, maintain, and protect such
temporary waterlines as it will require to perform the work under its contract.

3. The Plumbing Contractor shall be responsible for the removal of a temporary water supply line, if installed, and restoration which may be required because of same.

I. Telephone Services. The Contractor shall obtain and pay for all expenses associated with temporary telephone, fax, etc., services. Service shall be arranged by calling the Office of Telecommunications (OTC) Business Office at (814) 863-7096. The Contractor shall inform OTC of the company name, services desired, location, contact name, billing address, and telephone and fax numbers. OTC will initiate the service order and all one-time, ongoing, and disconnect charges shall then be billed directly to the Contractor. The Contractor shall notify OTC when service is required to be disconnected.

J. Temporary Heat

1. The temporary heat requirements are divided into two categories; i.e., (1) temporary heat required prior to the enclosure of the structure, structures, or portions thereof; (2) temporary heat required subsequent to the enclosure of the structures.

2. A structure shall be considered to be enclosed when (a) the roof is on and tight; (b) the exterior walls have been completed to the extent that heat will be retained within the structure; and (c) when openings, doors, and windows are closed with permanent closures, or with substantial temporary closures which will affect the retention of heat within the structure.

3. Where projects are multistory, which are more than three levels or stories above grade, a building shall be defined as "enclosed" when all of the requirements of the preceding paragraphs have been met, except that the stipulation that the roof shall have been complete, shall not apply as long as the floor construction of the level above the proposed working area is complete, and as long as all stairs or other openings, which penetrate or project through the ceiling or the floor above the proposed working area have been protected.

4. Prior to enclosure of structures, or portions thereof, and when official local weather predictions indicate below freezing temperatures, the General Contractor shall provide, maintain, operate, and pay all costs including fuel for a sufficient number of approved portable heaters so that the progress of the work of all Contractors is not impeded, and proper protection of all work from freezing is maintained. Self-contained oil-fired portable heaters, which release the products of combustion inside the structure, may be used only in areas where finish work has not been started and there, only if, in the opinion of the Professional, the possible deposit on the structure interior will not have an adverse effect on the finish work to be installed.

5. Temporary heat in the enclosed structures will be required on a twenty-four hour basis when the ambient temperature is officially predicted or is actually at 35°F, or lower.

Temporary heat may be required at times other than above in order to maintain job progress and will be the responsibility of the respective Contractors to supply and pay all costs thereof.
6. After the structure is enclosed and temporary heat is required for proper construction as determined by the Professional or the University, the Heating Contractor, at his own cost and expense, shall provide the equipment and heating personnel for temporary heat. The Heating Contractor may install gas or oil-fired portable heating units provided the products of combustion are totally vented outside the building. The Heating Contractor, upon approval by the University, may utilize the permanent system or portions thereof or may install temporary steam or hot water radiation or convection or a combination of both. If the permanent system is used and water treatment equipment is to be installed as part of the contract, then such equipment is to be installed and operated to protect the system. The Heating Contractor shall operate portable steam or hot water generating equipment for supply to permanent or temporary structure heating facilities unless steam is available from University lines. The Heating Contractor may install, valve, meter, operate, protect, and maintain a temporary steam heating system through connections to existing University steam lines, but may do so only if the University will state, in writing, that the existing steam system can supply sufficient quantity of steam to meet the Professional's estimate of the quantity that will be needed to maintain adequate temporary heat. The University, within its facilities, will furnish steam for temporary heat under a specified schedule of charges.

7. Temporary heating system shall be of sufficient capacity to heat the interior of the building to 50°F, when the outside temperature is 0°F. Temperature at all times must be 50°F or above. This service shall be continued until the entire project is completed.

8. Where electricians or plumbers are required to install, operate, supervise, or maintain equipment used in the provision of temporary heat, the payment for the services of such personnel shall be the responsibility of the Electrical or Plumbing Contractor, respectively.

9. The General Contractor, at its own cost and expense, shall remove all soot, smudge, and other deposits from walls, ceilings, and exposed surfaces which are the result of the use of any temporary heating equipment, including the use of the permanent heating system for temporary heating purposes. The Contractor shall not do any finish work until all such surfaces are properly cleaned.

10. All permanent heating equipment used to supply temporary heat shall be completely cleaned and reconditioned as necessary by the Heating Contractor prior to final acceptance by the University. All permanent heating equipment such as radiator trap seats and diaphragms, valve seats and discs, strainer internals, or any other equipment found to be damaged due to being used for temporary heat shall be replaced. All such replacements must be checked and approved by the University.

11. The use of either temporary or permanent electric resistance heating will not be permitted for temporary heat. Where permanent electric resistance heating is specified, temporary heat shall be independent of the permanent system.

K. Construction Light and Power

1. All references made herein to the Electrical Contractor shall refer to the Electrical Contractor performing the work under the contract.
2. The Electrical Contractor shall contact the University and make all arrangements for the electric service. The Electrical Contractor shall install a KWH demand plus KWH metering and billing meter for all construction light and power taken from the University system as specified above.

3. The Electrical Contractor shall arrange with the University for service from the existing lines. Electrical Contractor shall furnish and install a circuit breaker or fused switch of sufficient capacity to handle the construction load at the building. Electrical Contractor shall also furnish secondary service for lighting only to each Contractor's office. The current transformers and metering will be installed by the Electrical Contractor.

4. At University Park Campus, where temporary electric service is secured from the University's 5 KV or 12 KV distribution system, the Electrical Contractor shall install the system in the same manner as if the system were permanent. This includes fused disconnects installed as close as possible to the tap to the University's system, 5 KV or 15 KV shielded cable as required, proper termination of cable including stress cones, grounding, lightning arresters on overhead lines and proper insulators and adequate clearance for overhead lines. Transformer bank shall be connected for a balanced 120/240 V distribution except when directed otherwise.

When this installation is complete and before connections may be made, the University shall be notified so that arrangements can be made for testing, inspection, and approval by the University before final connection is completed.

It will be the University's option to waive the test.

All interruptions to University services must be scheduled two (2) weeks in advance. In order to keep the downtime to a minimum, the Electrical Contractor shall complete as much of the work as possible prior to the interruption.

5. The temporary service distribution points shall be located as near as possible to the building and shall not cause an obstruction or interference to other Contractors in the performance of this work.

6. The Electrical Contractor shall furnish and install the temporary electrical services for construction light and power for all Contractors, maintain and operate the services as long as required during the entire period of construction for the project. Temporary electrical service shall be supplied during normal daily working hours based upon a forty-hour work week. When any Contractor requires service beyond the above, that Contractor shall be responsible for the cost thereof.

7. The Electrical Contractor shall provide all wiring, safety switches, panels, poles, supporting structures, lamps, and weatherproof sockets, all of which shall be properly and safely installed.

8. The Electrical Contractor shall provide a 100-watt electric lamp and 120-volt power receptacles approximately every fifty (50) feet on the lines in weatherproof sockets. These facilities shall be installed so as to light all exitways, stairway landings, and to provide one light and one receptacle for each 1,000 square feet in all spaces which exceed 1,000 square feet. Lights shall be provided with protective cages.
9. Where temporary electrical service is required at the Commonwealth Campuses, and this service is secured from the high-voltage distribution system, the Electrical Contractor shall make all arrangements with the local electric utility company for obtaining temporary electric service. As a minimum, the temporary service installation shall meet all requirements of the utility company. Where the utility company requirements are less stringent than the requirements herein specified, at the option of the University, the more stringent requirements shall be applied.

10. The Electrical Contractor shall provide three (3) 208-volt, single-phase power receptacles, each rated at 4,000 watts, outside the building. The maximum size motor to be used by any Contractor shall be limited to five (5) horsepower. Where a service of a type other than that herein specified is required, each Contractor requiring same shall furnish and install and pay all costs for special services. If special service is not available, the Contractor requiring same shall furnish, install, and maintain separate internal-combustion engine-generator sets. Electrical power will not be made available for welding machines or electric heating equipment.

F-16 Electric Power Equipment

A. Due to the limited capacity of electric distribution on the Campus, the use of A.C.-powered welders and electric heaters is prohibited.

F-17 Temporary Sanitary Facilities

A. Sanitary facilities will not be provided by the Owner. The use of Owner's facilities is prohibited (unless prior approval is granted by the Owner).

B. The General Trades Contractor shall, at its own cost and expense, provide, operate, and maintain in a clean and sanitary conditions, adequate sanitary facilities as approved by the Owner.

1. All sanitary facilities shall be fully enclosed buildings, screened against insects.

2. Open-pit type facilities will not be permitted.

3. Deleted text. [C]

4. When directed by the Owner, the Contractor shall dismantle and remove these facilities and leave the premises clean as required.

5. As soon as permanent soil lines have been installed inside the building, the Plumbing Contractor shall install two temporary water closets and two lavatories. These shall be kept in working order by the Plumbing Contractor and shall be maintained in a clean and sanitary condition by the General Trades Contractor.

6. The use of self-contained "Job-Johnny" units will be permitted upon approval by the Owner.
F-18 Existing Underground Service and Utility Lines

A. Notification to Public Utilities Prior to Excavation or Demolition Work When Using Powered Equipment or Explosives.

1. All Contractors shall comply with all requirements of the Act of December 10, 1974 (P.L. 852, No. 287), referred to as the Underground Utility Line Protection Law, as amended by the Act of December 12, 1991 (Act No. 1991-38), prior to excavation or demolition work when using power equipment or explosives.

B. At all locations, all underground utilities or service lines uncovered or exposed by the operations under the contract shall be adequately protected by the Contractor, who shall be responsible for the repair of any damage to such services. Contractor shall be responsible to the Owner for all costs resulting from the Contractor’s damage to University lines. These include, but are not limited to material cost, wages, supervisory professional costs, disruption of services, research, and overhead costs. Contractor must notify the University immediately of any damages to utility lines and street lighting. Repairs shall be made by a method approved by the University.

F-19 Interruption of Existing Services

A. Utilities serving existing buildings, installations, or facilities shall not be interrupted until the Contractor has made the necessary arrangements with and has received approval from the University.

B. In the event that interruption of any existing utility service is necessary, the responsible Contractor shall be required to make all arrangements for shutdown and start-up of such service with the University representative, and shall pay all costs for such interruption and service restoration.

C. University crews must be used to shut down and start up all services which require interruption for temporary or permanent connections.

D. All planned interruptions to University services must be scheduled two (2) weeks in advance and the work will generally be done outside of normal working hours.

F-20 Laying Out the Work

A. The General Trades Contractor shall employ a competent, experienced engineer and have the engineer determine all lines and grades and certify same from time to time during the progress of the work.

1. The General Trades Contractor shall procure services of a registered land surveyor to perform the field layout work for establishing primary site lines and levels. If any of the control points initially are moved or lost, control points shall be re-established by the General Trades Contractor at no additional cost to the Owner. Contract work shall properly relate to lines and levels and detail dimensions shown or established by supplemental drawings.

2. All engineering or field layout for points necessary to perform work is the responsibility of each Prime Contractor and all such information must be copied to the Construction Manager.
3. All other layout is the responsibility of each Prime contractor. Contractors shall exercise proper precaution to verify the dimensions shown on drawings prior to laying out work and report any inaccuracies or errors to the Construction Manager prior to beginning work. The contractor shall be held responsible for any error resulting from failure to exercise such precautions. Coordinate and check all other dimensions and levels as necessary for detailed layout work. All discrepancies, which are found, must be coordinated with the Construction Manager prior to proceeding with the work.

4. Contractors are cautioned that temperature corrections during all surveying and layout must be used. Contractors will be responsible for any and all extensions of lines and grades necessary for their work.

5. Contractors are expected to broom clean as necessary for their own layout.

6. At the request of the Construction Manager provide certification, signed by the Contractor's retained field engineer, certifying that elevations and locations of improvements are in conformance or nonconformance with requirements of the Contract Documents.

F-21 Measurements

A. Before ordering material or proceeding with the work, the Contractors shall verify all measurements at the site. No extra compensation will be allowed because of differences between actual measurements and dimensions shown, but such differences shall be referred to the Professional for consideration before proceeding with the work.

F-22 Clearing of Roads, Parking Areas, and Traffic on Campus

A. The General Trades Contractor shall daily clean all mud, dirt, and debris resulting from all Contractors’ operations from the adjacent streets, sidewalks, drives, and parking areas, and shall repair all damage caused by the cleaning. If the Contractor fails to clear mud and construction debris from roads and walks, the University will clear this mud and debris and bill the Contractor(s) at cost.

B. All traffic will be subject to the rules and regulations and penalties of its University and applicable local laws. All hauling and construction traffic shall use only those roads designated by the University. The use of Jake Brakes on campus is prohibited.

C. Contractors shall carefully schedule delivery and installation of its work so to cause the least interruption of normal rush-hour traffic.

D. The General Trades Contractor shall maintain streets, sidewalks, and driveways free of encumbrance at all times for pedestrian and automotive traffic. When necessary to block these off, do so only with prior approval of the University and only at designated time. Each closing must have the prior approval of the University.

E. Parking for Contractors’ employees is prohibited on campus roads, drives, and courts.
F. Where mud, snow, ice, or other hazardous conditions exist, the General Trades Contractor shall remove the hazards or shall provide and maintain such temporary pathways as are required for safe and expeditious prosecution and inspection of the work of all trades.

F-23 Cleanup

A. The General Trades Contractor shall take precautions against the presence of rats, mice, and other pests. The General Trades Contractor shall exterminate them if they are observed, engaging a reputable exterminating firm to give regular service as necessary.

B. Each Contractor shall keep the premises clean at all times of dirt, rubbish, and debris resulting from the work of all contracts, and shall remove all rubbish and debris in metal containers at the end of each working day. Each Contractor shall remove all rubbish and cartons resulting from the installation of fixtures and equipment. Disposal of materials by burning at the site is expressly prohibited. The Contractor will not use the University's trash collecting containers.

C. Prior to substantial completion of the work, each Contractor and Subcontractor shall do the final cleaning of the surfaces of all the Contractor's installations as may be required by the various specification sections.

D. Each Contractor, in addition, shall employ a professional cleaning organization to remove all paint and stains from glass and to wash all glass throughout the work, to clean and polish the finished surfaces of all fixtures, equipment, and accessories and to vacuum clean all floors.

E. All permanent equipment used to supply temporary services shall be completely cleaned and reconditioned by the appropriate Contractor prior to final acceptance by the University. Filters shall be in clean condition, interiors of all strainers shall be replaced or cleaned and seats on all valves and diaphragms on all traps of all sizes of the used portions shall be examined, cleaned, and replaced as necessary to the satisfaction of the University. Costs of cleaning, reconditioning, and replacement of parts of the permanent systems shall be at the expense of the responsible Contractor.

F. If a Contractor fails to clean up, the University may do so and the cost thereof shall be charged to the Contractor as provided in the General Conditions.

F-24 Existing Facilities

A. The University will maintain activities and normal office hours in the building during the course of this construction project. Difficulties of working in an existing operational building are recognized; however, the Contractor must cooperate to keep noise, dirt, and other interferences to a minimum. Housekeeping shall be such to assure no disruption of the University's operations and the Contractor shall schedule his work well in advance and give notice to all building occupants of any disruption.

B. Existing facilities must be maintained watertight and dust free at all times. The Contractors shall make all necessary provisions to this end and shall be responsible for any damage resulting from noncompliance with this requirement.

F-25 Requirements During Construction
A. Fence open ditches. Where walks cross such ditches, bridged walkways must be provided with rails on both sides. Bridged walkways must be adequately lighted at night.

B. Service temporary walks and roads with No. 2 crushed stone if they are to be in public use.

C. Walks and roadways used by both Contractor and the public shall be kept in repair and cleared by the Contractor at least once each day and more often as conditions require.

D. Place no obstructions on or within fifteen (15) feet of fire hydrants. Hydrants must be accessible for fire fighting purposes.

E. Protect and attend any type of temporary heating units used.

F. Where walkways, roadways, or entrances used by the public are adjacent to or pass under construction scaffolding or near building edge, the Contractor shall provide an adequate covering for such area to protect passersby from falling objects.

G. All temporary construction sheds, trailers, and flammable liquid storage areas belonging to Contractors shall be so placed on the construction site to minimize any danger to University property and the public.

H. The University Department of Environmental Health and Safety is available for consultation regarding the above items and any other safety matter.

F-26 Protective Barricades

Contractors shall be aware that the University community includes many people with disabilities (visually impaired, wheelchair-bound, etc.), requiring extra attention on the part of the Contractor to assure that construction work is properly identified and protected. The following provides minimum protective measures to be followed by Contractors doing work beyond the main project construction fence in order to protect the general public from hazards created by open excavations, manholes, etc.:

A. Any excavations outside the project fence shall be adequately protected to prevent falls, injury, or other hazard to the general public and University population, as follows:

1. Excavations for the purpose of constructing/installing manholes, meter pits, valve pits, or similar appurtenances must be completely surrounded by a rigid fence (not flagging tape or plastic netting) of sufficient height and strength to prevent individuals from crossing into the excavated area. Such fencing shall incorporate toeboards around the bottom and must be positioned and sufficient distance from the top of excavation to provide adequate protection against undermining or sloughing off of the excavation slopes.

2. Ditch excavations, such as for electrical, water, sewer, steam, gas, or other underground utility lines, shall, as a minimum, be protected on all sides with snow fencing or similarly strong material; fencing shall be positioned a safe distance away from the top of slope of the excavation.

B. Construction equipment used for hoisting men or materials (e.g., cranes and "cherrypickers," construction line trucks, mobile platforms, etc.) must be
surrounded by appropriate protective barricades, safety lines, and signage to alert passersby of the presence of overhead loads and to provide adequate clearance around all boom swing areas, tail swing areas, overhead loads, and operating machinery. Passersby shall not be permitted to travel beneath suspended loads under any circumstances. If necessary, Contractor shall provide a flagman to assure safe passage of pedestrian and vehicular traffic.

C. Open manholes must be protected at all times by a rigid, fence-type barricade around the opening.

D. Flagging tape and traffic cones are not, under any circumstances, suitable or permissible barricading materials.

E. Contractors shall notify—and receive approval from—the University's Construction Inspection Office prior to beginning any excavation or opening of any manholes outside the project fence. The Inspection Office will then advise the appropriate University office of the hazardous condition, including location, approximate starting time, and expected duration of the situation.

F. Contractors shall report immediately to the University's Construction Quality Representative any accident or other incident, no matter how minor, which involves any member of the general public. The telephone number of the University's Construction Inspection office is (814) 863-3316.

F-27 Delivery and Storage

A. On-Site. All materials and equipment shall be delivered to the site and stored at locations approved by the University. Each Contractor shall be responsible for proper care and protection, and shall protect and be responsible for any damage to its work or materials from the date of the Agreement until final payment is made, and shall make good without cost to the University any damage or loss that may occur during this period. All cement, lime, and other materials which may be affected by the weather shall be covered and protected to keep them free from damage while they are being transported to and stored on the site. Should any materials be found defective or in any way contrary to the Contract, this material, no matter in what stage of completion, may be rejected by the Professional and/or the University and shall be removed from the site at once.

B. Inside Building. In no case shall any materials be stored in mechanical and electrical spaces, nor shall any paint or other combustible supplies, tools, or equipment be stored in the building, except in tightly sealed metal containers, in well-ventilated spaces, and in a quantity limited to that day's need.

C. Provisions for Large Items. The General Trades Contractor shall make provisions for bringing into the building large items of equipment by leaving temporary openings for them as determined to be required. After the equipment is set in place, the General Trades Contractor shall close the opening as required.

D. Materials must be stored in such a way as not to damage existing structures or surrounding area. Any material or equipment stored on the roof of any building must be placed on dunnage and not directly on roof surface.

F-28 Fire Protection

A. The General Trades Contractor is responsible to maintain overall site safety including fire extinguishers inside the new building structure that meets OSHA requirements. Each contractor and subcontractor must supply and maintain a fire
extinguisher in all temporary rooms (including jobsite trailer), at flammable material storage areas, and at all locations where welding or burning occurs.

B. No fires for any purpose shall be permitted on the project. Remove all refuse from University property.

A. No welding, cutting by torch, or work utilizing or causing inflammable wastes shall be done unless adequate fire protection is provided and maintained for the duration of the work in the area of operations. University welding/cutting permits will be required and shall be issued at no cost to the Contractor by the University.

F-29 Job Site Security

A. The University will not provide job site security.

B. The University assumes no responsibility for damage or loss to the Contractors’ property.

F-30 Dewatering

A. The General Trades Contractor shall assume responsibility for continuous removal of all water, including surface and rainwater, by the use of pumps, drains, and other approved methods necessary to keep the excavation and site free from water at all times until completion.

B. All water must be directed away from existing structures, shall cause no erosion and shall prevent foreign material from backing up existing drains or entering into the sewers.

F-31 Fastening Devices

A. Fiber, plastic, lead plugs and shields, and any devices using wood screws are not acceptable as fastening devices to plaster, tile, concrete, or masonry. Use expansion bolts or driven devices in solid construction, and toggle bolts in hollow construction.

F-32 Welding

A. All welding and cutting shall be done by qualified and certified welders. Certificates shall be filed with the Professional and the University prior to commencement of any welding.

F-33 Noise Control

A. In most instances, noise control will be a matter of prime concern. It is, therefore, mandatory that all equipment such as compressors, generating equipment, etc., shall be fitted with mufflers or other noise abatement attachments.

B. It may become necessary to schedule some operations during periods of low occupancy of neighboring buildings.

F-34 Provision for People with Disabilities

A. All structures designed for general use, shall comply with all local, state, federal, and University regulations for facilities to accommodate people with disabilities.
F-35  **Asbestos Removal**

A. The University has an ongoing asbestos identification and removal program. On renovation projects where the possibility exists that material containing asbestos fibers may be encountered, the situation will be reviewed by the University and a course of action determined.

B. Possible asbestos removal situations will be discussed between the Professional and the University on a project-by-project basis.

C. If asbestos is found to be present after construction is underway, the University Construction Inspection Office is to be notified immediately so that proper removal work can begin promptly. Removal or repairs will then be initiated following all applicable EPA and OSHA regulations.

F-36  **Advertising Signs**

A. Neither the Professional nor Contractor shall erect advertising signs.

F-37  **Project Sign**

A. On projects funded solely by the University, a project sign shall be prepared and erected by the General Trades Contractor and shall conform to the Specifications provided by the University.

B. The appropriate project name shall be inserted.

F-38  **Warranty Period**

A. During warranty periods, the University will respond to emergency situations, that is, situations determined to be potentially harmful to the surrounding personnel, equipment, or environment. In cases where work is performed by University employees, the Contractor will be charged for all labor and material needed to complete emergency repairs, if the repairs are determined to be the result of faulty material or workmanship. The performance of these repairs shall not void any Contractor's warranties.

B. The University will begin preventive maintenance programs immediately following final inspections. Preventive maintenance activities shall not relieve the Contractor from any equipment warranties.

F-39  **Schedules and Reports**

A. Refer to General Conditions of the Contract, Article 11, for a detailed breakdown of information required.

B. Together with each monthly application for payment, the Contractor shall forward to the University a summary report of the progress of the divisions of the work.

F-40  **Confined Spaces**

A. All Contractors will have a written OSHA compliant permit-required confined space program.

F-41  **Demolition Work**
A. Contractor is responsible for PA DEP/EPA notifications required for demolition work. Paperwork must be submitted to the Owner for review prior to submission to the proper agencies. Notification form templates are available from the Owner.

B. Demolition Contractor performing work requiring notifications must be prequalified by the Owner.

F-42 INFORMATION REQUIRED BEFORE STARTING WORK – The Contractor will provide the following information not later than thirty days following the execution of the Contract.

F-42.1 Detailed Work Plan
Each contractor shall submit to Construction Manager a detailed work plan outlining all phases of their work. At a minimum, this written plan must include:

A. A Logistics Plan that describes in detail the methods that will be used to perform your scope of work. The plan must identify major equipment that will be used, any temporary utilities that will be required to perform your work, and how materials will be brought on-site and/or how debris will be removed from the site.

B) A Project Schedule On bid day each contractor must provide a schedule indicating major durations for their portion of the work. By thirty days after execution of the Contract each Prime Contractor shall have submitted to the Construction Manager and the General Trades Contractor and schedule outlining all phases of the work that clearly identifies sequence of work, manpower requirements, duration to complete each major work area, critical starting dates, long lead item approval/release, delivery dates and expected shift work. This schedule must be coordinated by the General Trades Contractor with all other Prime Contractors into a Project Schedule and be signed off by those Prime Contractors at the time of submittal. As work progresses, updated 2-week look-ahead schedules must be provided to coincide with project meeting dates. In addition, a shop drawing submission schedule must be provided within ten working days showing all items requiring shop drawings and/or catalog cuts. This schedule must specify the estimated dates of submission, fabrication times, the delivery dates required to maintain the Project Schedule, and be tied to the master Project Schedule.

C) A project specific Staffing Plan that identifies who will manage the overall scope of your work for this project. This plan will identify (by name) the individual staff members you will use on the site. Additionally, the work experience resumes of the listed management individuals must be submitted. The contractor shall provide supervisory personnel consistent with the size and complexity of the project, who shall be fully capable of controlling their workers, coordinating work through the Construction Manager, performing in harmony with other trades, and completing work in accordance with the schedule.

D) Each Prime Contractor shall furnish a list of Subcontractors, Suppliers, and Vendors, including phone numbers and email addresses as required, which they propose to use on the Project.

E) All contractors, subcontractors and sub-subcontractors, shall comply with all federal, state and local laws and regulations regarding equal employment opportunity.
F) A schedule of values detailing project costs by area. This schedule is to be reviewed and approved by the Owner and Architect and will be the basis of pay application requests as the project progresses.

G) All required contract documents including but not limited to signed contracts, approved insurance certificates and all bonds.

F-42.2 Safety Procedures Manual
Prior to beginning any work on site, each Contractor shall submit an OSHA compliant site specific Safety Procedures Manual that identifies all site-specific safety issues related to his work and details how each will be addressed. This manual will include the Material Safety Data Sheets (MSDS) for all potentially hazardous substances that will be used in performing the scope of your work. In addition, a site specific Hazardous Substance Survey Form that outlines all of the MSDS sheets applicable to this project must be submitted. MSDS inventory log shall be updated weekly. One (1) copy of this plan must be held on site in the Construction Manager’s project office.

F-42.3 Crane Inspection Report
All Contractors whose work includes the use of material or personnel lifting devices must submit a copy of the Annual Crane Inspection Report prior to starting work. The report must conform to either OSHA section 1910.180 or section 1926.550. Note that this is not referring to a Crane Safety Checklist but rather the Annual Crane Inspection Report. If a crane is brought on site without proper documentation or inspection, said crane will be removed at once from the site, with any associated charges borne by the responsible Contractor.

F-42.4 Pre-Installation Conference
The contractor shall arrange for a meeting on site with the Construction Manager 2 weeks prior to the scheduled start of his work. These meetings will be required for items as detailed in the schedule of values or as necessary during the course of the work. This meeting will discuss:

A.) Review progress of other activities and preparations for the activity under consideration, including schedules, safety, submittals, manufacturer’s recommendations, weather limitations, substrate acceptability, compatibility problems, and inspection and testing requirements.

B.) Record significant discussions, agreements, and disagreements of each conference, along with the approved schedule. Distribute the meeting record to everyone concerned. The minutes will verify that the items listed above were discussed, and will document the actions taken or required and by whom the action is required. The Contractors are required to review these minutes and submit any objections to the Construction Manager within 3 days or the minutes recorded will stand as record.

C.) A list of contractor key personnel, with address and telephone numbers for emergency calls (both work hours and non-work hours).

D.) Contractors are expected to be experienced and familiar with the requirements and conditions imposed during the performance of similar work in this area. Some of these requirements are the performing of normal “out-of-sequence” work, and non-continuous work.

E.) The contractor shall maintain the progress of his work, consistent with the project schedule. Failure of the contractor to maintain such progress shall make the contractor liable for all costs incurred by Owner as a result of the contractor’s delays including, but not limited to claims by other contractors.
and/or penalties imposed by the Owner. In addition, the contractor is required to provide a recovery schedule within 24 hours of its failure to maintain progress.

F.) Contractors shall have responsible representations at job meetings held and scheduled by Construction Manager at their Field Office. Contractors failing to attend and abide by the content of these meetings may be held responsible for any delays and/or expenses incurred due to coordination difficulties in their trades.

G.) Before commencing any work, consult with the Construction Manager regarding the use of the facility, including but not limited to, roads, walks, ramps, garage, parking areas, storage areas, corridors, stairs, etc., that may be required to prosecute work.

F-42.5 Waiver of Liens as required.

F-42.6 Communications
Any and all communication with the Architect and/or Owner shall flow through the Construction Manager. There shall be no direct communication with the Architect and/or Owner without prior knowledge and/or written consent of the Construction Manager.

F-42.7 Permits and Fees:
Each Prime contractor except General Trades shall secure and pay for all permits and governmental fees, licenses and inspections necessary for the proper execution and completion of the Contract. The Pennsylvania State University will provide to the General Trades contractor the general building permit. All permits and inspection reports will be copied to the Construction Manager and posted as required.

F-43 SITE LOGISTICS (See attached Site Logistics Plan)

F-43.1 Material and Equipment Storage/Staging
Construction materials and equipment deliveries must be scheduled with the Construction Manager and are subject to coordination with other trades. Contractors are to bring only that material which will be used in a reasonable time frame as reflected by associated activities in the construction schedule. The extent of storage materials and equipment at the site shall be approved on an ongoing basis by Construction Manager in coordination with other trades. If stored material or equipment obstructs the progress of any portion of the work or interferes with the day to day operation and work flow, they shall be removed or relocated by the contractor as directed by the Construction Manager without reimbursement of costs. All materials shall be stored in an orderly manner and material security is the responsibility of the Contractors. Improperly stored items may be rejected from use on the project.

All equipment must be in compliance with all local, state, and federal regulations relating to its safety.

If in the opinion of the Construction Manager, the jobsite cannot accommodate either early or bulk delivery of materials or equipment, the Contractor will make off-site arrangements for safe and secure storage at no additional cost.

F-43.2 Equipment Locations
The locations of cranes, mixers, field offices, workbenches, cutters, hose lines, etc., must be approved by the Construction Manager prior to utilization on this project. In addition, any contractor wishing to place a crane upon this project for the purpose of lifting materials or equipment must submit a lifting procedure safety plan and a current inspection certificate. This contractor will be responsible to erect, remove, maintain and replace any required safety barriers and restore the erection area when complete.

F-43.3 **Construction Fencing, Gates and Barricades**
The Construction Manager will provide the perimeter construction fence and gates. Any fencing, barricades or flaggers for utility or other work outside the perimeter construction fence (see logistics plan section H3) in the responsibility of the Prime Contractor Completing the work. Anytime that either pedestrian or vehicular traffic is affected by the Prime Contractors work, flaggers will be required unless a safe detour with proper signage can be provided and the detour is approved by the Construction Manager and Owner.

F-44 **JOBSITE RULES AND MISCELLANEOUS REQUIREMENTS**

F-44.1 **Project Staff**

All trades, including but not limited to, demolition, general trades, mechanical, plumbing, HVAC, and electrical shall provide qualified and experienced Project staff including Project manager, coordinator/Project engineer, quality assurance/quality coordinator, environmental health and safety officer, and superintendents. Failure to maintain a superintendent on the Project site at all times work is in progress shall be considered a material breach of the Contract, entitling the Owner to seek equitable reimbursement by the Contractor, for durations until the superintendent is on the Project site full time. All communication given to or produced by the Project staff shall be binding as if given to or produced by the Contractor. The superintendent and/or other required Project staff shall be in attendance at the Project site not less than eight hours per day, five days per week, or as required when work is in progress. The Contractor or any other entity shall not employ the superintendent on any other project during their specified term at the Project site. Other members of the Project Staff will process work for the project so as to meet all deadlines/milestones of the project schedule and/or as required by the pace of construction.

F-44.2 **Communication**

Correspondence boxes for each contractor will be set up in Construction Managers field office. It is expected that correspondence be picked up daily while working on site. All site superintendents must have a working cellular phone equipped with voicemail for the duration of the project and during normal working hours.

F-44.3 **Daily Construction Reports**

Daily Construction Reports should be complete per project specifications and returned to Construction Manager. Each Prime Contractor is required to complete and submit daily reports. Payments may be withheld upon failure to submit these reports.

F-44.4 **Jobsite Conduct**

Each Contractor’s management team should review with all their employees that it is imperative that their conduct be socially acceptable at all times. Vulgar or abusive language, sexually suggestive comments or gestures are strictly prohibited and will result in immediate removal from the jobsite and/or criminal prosecution.

F-44.5 **Limited Access Areas**

Due to the fact that a day care facility, laboratories performing experiments and experimental animals are housed in buildings adjacent to the construction site no
employees of the prime contractors or their subcontractors will be permitted to enter the adjacent buildings (Henderson Building, Henderson North, Henderson South and Health and Human Development East) without coordination with PSU and MCMS. Workers entering these facilities without the knowledge of either PSU or MCMS will be subject to expulsion from the project site.

F-44.6 Clothing
Proper attire is required on-site. Full-length pants, full length shirts with sleeves, hard sole work boots are required along with any/all safety equipment prescribed in each contractor's safety plan. Wearing no shirt or tennis shoes is prohibited.

F-44.7 Lunch Areas
All Contractors must provide a container within their break/lunch area for the placement of trash. The areas used for construction lunches are to be kept clean and orderly. The Contractors will provide the labor necessary to clean common use areas daily and dump these public trash containers each day.

Recycling of Lunch waste will also be required as part of the LEED requirements for this project. Each Prime Contractor will be responsible for lunch waste recycling for their workers and subcontractors.

F-44.8 Damages
All contractors are cautioned that since this work will be performed in close proximity and adjacent to existing occupied properties, all precautions, protection and care must be exercised to protect existing structures in accordance with good safety practices. This is particularly applicable to protection for pedestrians.

The contractor is responsible for any damage, which may occur to the property of the owner or adjacent private or public properties which in any way results from the acts or neglect of his employees.

In Addition, repair and make good, at the expense of the Contractor, all damages thereto including damage to existing utilities and paving arising from operations under the Contract. Repair and protection is the Contractor's responsibility, regardless of the assignment of responsibility for inspection, testing, or similar services.

F-44.9 Quality Control
In addition to the requirements of the specifications, the following shall also apply: It is in the best interest of both Massaro and the contractor to provide top quality workmanship and materials in accordance with the contract drawings and specifications. The contractor agrees to actively participate in Construction Managers Quality Control Program and to correct deficient work immediately upon its discovery at no additional cost to the Construction Manager or the Owner.

Protect construction for quality control service activities until accepted through the Substantial Completion process including inspections by Architects and Engineers.

F-44.10 Manufacturer's Field Services
When directed by the Construction Manager, require the manufacturer or supplier of a product or service connected to the project to have qualified personnel provide on-site observations and recommendations at no additional cost to the Owner. Representative shall submit written report to the Architect and the Owner listing observations and recommendations. The Manufacturer shall validate the quality of workmanship and materials when required by manufacturer warranty and site visits by Construction Team Members may be required. Comply with manufacturer's installation instructions and recommendations, to the extent that those instructions
and recommendations are more explicit or stringent than requirements contained in Contract Documents

Provide attachment and connection devices and methods necessary for securing Work as required by the manufacturer, even if they are not illustrated on the Contract Documents.

F-44.11 Continuing Performance
Pending final resolution of a claim, unless otherwise agreed to in writing, the contractor shall proceed diligently with performance of the contract and payments shall continue to be made commensurate with that performance in accordance with the contract documents.

F-44.12 Owner Related Issues
The Owner shall, in conjunction and coordination with the Construction Manager, have the right to place and install equipment during progress of the work and the contractor agrees that such placing and installation of equipment shall not evidence completion of the work or portions of it, nor signify the Owner’s acceptance of the work or portions thereof.

Contractors are advised that the Owner may, at his discretion, employ other contractors or employees to perform work on this project. In such an event, all trades working under this contract shall cooperate in order that the work of all parties can be completed in reasonable order.

The Owner’s equipment suppliers shall be provided with reasonable use of power and light (normal working hours) necessary for the installation of their work without additional cost to the Owner or Construction Manager.

F-45 SITE STOCKPILES (SOILS)
The General Trades contractor is required to stock pile and maintain on site all topsoil removed for the new building footprint. Location on site to be coordinated with the Construction Manager

F-46 GENERAL PROTECTION

F-46.1 Protection of Finished Work
All Contractors are wholly responsible for the protection of finished work, both their own and that of others, as may be required to perform their work. Each Contractor is responsible for any damage, which may occur to the property of any other Contractor connected with the work, or to adjacent private or public properties, or to any portion of the structure that in any way results from the acts of neglect of his/her employees.

F-46.2 Cutting and Patching
All patching shall be done by tradesmen who are skilled in the required work. All patchwork will be done to the highest quality standards. Each contractor is responsible for all cutting and patching associated with the performance of their work under the Contract and shall include in their bid the cost of all cutting and patching required in connection with performance of his work. Include supports, protection from elements, protection of surroundings, and immediate clean up.
If necessary for the contractor to remove a minimal amount of spray on fireproofing after initial installation it will be his responsibility to replace or pay for the necessary patching.

All contractors affected by temporary utilities/openings shall include necessary comeback to infill, patch, etc.

The Contractor shall not damage or endanger any portion of the work of other Contractors or property of the Owner. The Contractor shall not alter the Owner’s or other Contractor’s work without written consent of the Owner or other Contractor. All such requests shall be made through the Construction Manager. Said consent shall not be unreasonably withheld.

If unsafe or unsatisfactory conditions are encountered, take corrective action before proceeding. Protect existing construction during cutting and patching to prevent damage. Until provisions have been made to bypass them, take all precautions necessary to avoid cutting existing pipe, conduit, or ductwork serving the building but scheduled to be removed or relocated. Where cutting is required use hand or small power tools designed for sawing or grinding, not hammering and chopping. Cut holes and slots neatly to size required to minimum disturbance of adjacent surface. Temporarily cover openings when not in use. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces.

F-46.3 **Perimeter Protection**
   It is the responsibility of the General Trades Contractor to conform to all OSHA requirements for fall protection for the building perimeters and interior openings.

F-46.4 **Penetration Protection**
   Each Prime Contractor is responsible for protection of any penetrations made in floors or roofs during installation of their work. Protection should be per OSHA requirements.

F-46.5 **Traffic Control**
   Provide traffic control barriers and flag persons throughout the construction period at any point in time that construction traffic obstructs normal traffic conditions.

**END OF SECTION**
SECTION G
BASIS OF BIDS
FOR

DGS CONTRACT #800-290.HA1.1 HAZARDOUS BUILDING MATERIAL ABATEMENT

G-01 General Requirements
A. Under the bidding items listed herein, the Bidders shall state, on the Form of Proposal, prices for each bid item listed
B. All requirements specified hereinafter for DGS CONTRACT #800-290.HA1.1 HAZARDOUS BUILDING MATERIAL ABATEMENT, Construction, shall govern, unless stated otherwise under any of the following Bid Items.

G-02 Basis of Bid For Bid Item No. 1
A. Bid Item No. 1, Base Bid, shall be the lump sum price for the entire work in accordance with the requirements specified hereinafter for DGS CONTRACT #800-290.HA1.1 HAZARDOUS BUILDING MATERIAL ABATEMENT, Construction, complete and ready for use.

G-03 Unit Cost #1
A. Provide Unit cost data as requested in Section H6, Appendix B of the “Asbestos Containing Material Removal Performance Specification”. Enclose Appendix B form loose indicating values with proposal.

G-04 Notice
A. The Form of Proposal (Section B) enclosed loose with the project specifications shall be used by Bidders in submitting their proposal.

G-05 Surety Company
A. Each Bidder shall note on the Form of Proposal (Section B) the name and address of its Surety Company.
B. Omission of the name of the Surety Company may be cause for rejection of any proposal.
SECTION G
BASIS OF BIDS
FOR

DGS CONTRACT #800-290.BD2.1 BUILDING DEMOLITION

G-01 General Requirements

A. Under the bidding items listed herein, the Bidders shall state, on the Form of Proposal, prices for each bid item listed
B. All requirements specified hereinafter for DGS CONTRACT #800-290.BD2.1 BUILDING DEMOLITION, Construction, shall govern, unless stated otherwise under any of the following Bid Items.

G-02 Basis of Bid For Bid Item No. 1

A. Bid Item No. 1, Base Bid, shall be the lump sum price for the entire work in accordance with the requirements specified hereinafter for DGS CONTRACT #800-290.BD2.1 BUILDING DEMOLITION, Construction, complete and ready for use.

G-03 Notice

A. The Form of Proposal (Section B) enclosed loose with the project specifications shall be used by Bidders in submitting their proposal.

G-04 Surety Company

A. Each Bidder shall note on the Form of Proposal (Section B) the name and address of its Surety Company.
B. Omission of the name of the Surety Company may be cause for rejection of any proposal.
SECTION G
BASIS OF BIDS
FOR
DGS CONTRACT #800-290.GC3.1 GENERAL TRADES

G-01 General Requirements
   A. Under the bidding items listed herein, the Bidders shall state, on the Form of Proposal, prices for each bid item listed
   B. All requirements specified hereinafter for DGS CONTRACT #800-290.GC3.1 GENERAL TRADES, Construction, shall govern, unless stated otherwise under any of the following Bid Items.

G-02 Basis of Bid For Bid Item No. 1
   A. Bid Item No. 1, Base Bid, shall be the lump sum price for the entire work in accordance with the requirements specified hereinafter for DGS CONTRACT #800-290.GC3.1 GENERAL TRADES, Construction, complete and ready for use.

G-03 Basis of Bid For Bid Item No. 2
   A. Bid Item No. 2, Alternate #1, shall be the lump sum deduct price to delete the brick wall veneer (corridor only) on floors 2, 3 & 4 and replace it with painted drywall. Painted drywall would be as per contract documents.

G-04 Basis of Bid For Bid Item No. 3
   A. Bid Item No. 3, Alternate #2, shall be the lump sum deduct price to delete the limestone wall veneer on the 1st floor in all areas (except Lobby F104, Interactive Research Commons 117 and Conference Rooms) and replace it with painted drywall. Painted drywall would be as per contract documents.

G-05 Unit Cost #2
   A. Provide Unit cost data for rock excavation and removal as an add or deduct per cubic yard measured in place that is less than or greater than information indicated on the bidding documents.

G-06 Unit Cost #3
   A. Provide Unit cost data for partial depth concrete repair as shown on the Civil Drawings and indicated in the “STEAM TUNNEL INTERIOR WALLS AND CEILING CONCRETE SPALL REPAIR”. Unit cost shall be indicated on a per cubic foot basis measured in place that is less than or greater than the estimated quantity indicated on the bidding documents.
G-07  Notice

A. The Form of Proposal (Section B) enclosed loose with the project specifications shall be used by Bidders in submitting their proposal.

G-08  Surety Company

A. Each Bidder shall note on the Form of Proposal (Section B) the name and address of its Surety Company.
B. Omission of the name of the Surety Company may be cause for rejection of any proposal.
SECTION G
BASIS OF BIDS
FOR
DGS CONTRACT #800-290.5 FIRE PROTECTION

G-01 General Requirements

A. Under the bidding items listed herein, the Bidders shall state, on the Form of Proposal, prices for each bid item listed
B. All requirements specified hereinafter for DGS CONTRACT #800-290.5 FIRE PROTECTION, Construction, shall govern, unless stated otherwise under any of the following Bid Items.

G-02 Basis of Bid For Bid Item No. 1

A. Bid Item No. 1, Base Bid, shall be the lump sum price for the entire work in accordance with the requirements specified hereinafter for DGS CONTRACT #800-290.5 FIRE PROTECTION, Construction, complete and ready for use.

G-03 Notice

A. The Form of Proposal (Section B) enclosed loose with the project specifications shall be used by Bidders in submitting their proposal.

G-04 Surety Company

A. Each Bidder shall note on the Form of Proposal (Section B) the name and address of its Surety Company.
B. Omission of the name of the Surety Company may be cause for rejection of any proposal.
SECTION G [C]
BASIS OF BIDS
FOR

DGS CONTRACT #800-290.3 PLUMBING [C]

G-01 General Requirements

A. Under the bidding items listed herein, the Bidders shall state, on the Form of Proposal, prices for each bid item listed
B. All requirements specified hereinafter for DGS CONTRACT #800-290.3 PLUMBING, Construction, shall govern, unless stated otherwise under any of the following Bid Items.

G-02 Basis of Bid For Bid Item No. 1

A. Bid Item No. 1, Base Bid, shall be the lump sum price for the entire work in accordance with the requirements specified hereinafter for DGS CONTRACT #800-290.3 PLUMBING, Construction, complete and ready for use.

G-03 Notice

A. The Form of Proposal (Section B) enclosed loose with the project specifications shall be used by Bidders in submitting their proposal.

G-04 Surety Company

A. Each Bidder shall note on the Form of Proposal (Section B) the name and address of its Surety Company.
B. Omission of the name of the Surety Company may be cause for rejection of any proposal.
SECTION G [C]
BASIS OF BIDS
FOR
DGS CONTRACT #800-290.2 HVAC [C]

G-01 General Requirements

A. Under the bidding items listed herein, the Bidders shall state, on the Form of Proposal, prices for each bid item listed
B. All requirements specified hereinafter for DGS CONTRACT #800-290.2 HVAC, Construction, shall govern, unless stated otherwise under any of the following Bid Items.

G-02 Basis of Bid For Bid Item No. 1

A. Bid Item No. 1, Base Bid, shall be the lump sum price for the entire work in accordance with the requirements specified hereinafter for DGS CONTRACT #800-290.2 HVAC, Construction, complete and ready for use.

G-03 Notice

A. The Form of Proposal (Section B) enclosed loose with the project specifications shall be used by Bidders in submitting their proposal.

G-04 Surety Company

A. Each Bidder shall note on the Form of Proposal (Section B) the name and address of its Surety Company.
B. Omission of the name of the Surety Company may be cause for rejection of any proposal.
SECTION G
BASIS OF BIDS
FOR
DGS CONTRACT #800-290.EL1.4 ELECTRIC

G-01 General Requirements

A. Under the bidding items listed herein, the Bidders shall state, on the Form of Proposal, prices for each bid item listed

B. All requirements specified hereinafter for DGS CONTRACT #800-290.EL1.4 ELECTRIC, Construction, shall govern, unless stated otherwise under any of the following Bid Items.

G-02 Basis of Bid For Bid Item No. 1

A. Bid Item No. 1, Base Bid, shall be the lump sum price for the entire work in accordance with the requirements specified hereinafter for DGS CONTRACT #800-290.EL1.4 ELECTRIC, Construction, complete and ready for use.

G-03 Basis of Bid For Bid Item No. 2

A. Bid Item No. 2, Alternate #3, shall be the lump sum deduct price to provide TP-1 efficiency in lieu of CSL3 efficiency for the low voltage transformers. Refer to specification section 26 22 00 for more detailed information.

G-04 Notice

A. The Form of Proposal (Section B) enclosed loose with the project specifications shall be used by Bidders in submitting their proposal.

G-05 Surety Company

A. Each Bidder shall note on the Form of Proposal (Section B) the name and address of its Surety Company.

B. Omission of the name of the Surety Company may be cause for rejection of any proposal.
SECTION G
BASIS OF BIDS
FOR

DGS CONTRACT #800-290.TL2.4 TELECOMMUNICATIONS (LOW VOLTAGE SYSTEMS)

G-01 General Requirements

A. Under the bidding items listed herein, the Bidders shall state, on the Form of Proposal, prices for each bid item listed.

B. All requirements specified hereinafter for DGS CONTRACT #800-290.TL2.4 TELECOMMUNICATIONS (LOW VOLTAGE SYSTEMS), Construction, shall govern, unless stated otherwise under any of the following Bid Items.

G-02 Basis of Bid For Bid Item No. 1

A. Bid Item No. 1, Base Bid, shall be the lump sum price for the entire work in accordance with the requirements specified hereinafter for DGS CONTRACT #800-290.TL2.4 TELECOMMUNICATIONS (LOW VOLTAGE SYSTEMS), Construction, complete and ready for use.

G-03 Notice

A. The Form of Proposal (Section B) enclosed loose with the project specifications shall be used by Bidders in submitting their proposal.

G-04 Surety Company

A. Each Bidder shall note on the Form of Proposal (Section B) the name and address of its Surety Company.

B. Omission of the name of the Surety Company may be cause for rejection of any proposal.
SECTION G
BASIS OF BIDS
FOR
DGS CONTRACT #800-290.LA4.1 LANDSCAPING

G-01 General Requirements

A. Under the bidding items listed herein, the Bidders shall state, on the Form of Proposal, prices for each bid item listed
B. All requirements specified hereinafter for DGS CONTRACT #800-290.LA4.1 LANDSCAPING, Construction, shall govern, unless stated otherwise under any of the following Bid Items.

G-02 Basis of Bid For Bid Item No. 1

A. Bid Item No. 1, Base Bid, shall be the lump sum price for the entire work in accordance with the requirements specified hereinafter for DGS CONTRACT #800-290.LA4.1 LANDSCAPING, Construction, complete and ready for use.

G-03 Notice

A. The Form of Proposal (Section B) enclosed loose with the project specifications shall be used by Bidders in submitting their proposal.

G-04 Surety Company

A. Each Bidder shall note on the Form of Proposal (Section B) the name and address of its Surety Company.
B. Omission of the name of the Surety Company may be cause for rejection of any proposal.
SECTION H – SCOPE OF THE WORK [C]

SCOPE OF THE WORK

The scope of work per bid package shall be included, but not limited to, the work in the respective specification sections, project drawings, contracts, and addendums without exception. The bid packages are to include all labor, materials, tools, equipment, and supervision required to complete the work unless specifically indicated otherwise. Prime Contractor contracts will obligate every bid package to the entire set of construction documents obligating each bid package/prime contractor and their subcontractors to coordinate their respective scope of work for all aspects in which it may affect or be effected by.

Project Specific Requirements to be included for All Bid Packages

1. This project is scheduled to start in December 2010, and be complete by or before October 2012.
2. Unless otherwise noted, all references to the Construction Manager doing work on the site should be deleted. The work will be assigned to the trade responsible for that specification section per their scope of work. You must review the full list of bid packages for assignment of specification sections and scope.
3. Massaro Construction Management Services, LLC., the Construction Manager will be responsible for the initial installation of site fencing and gates, fence fabric, tree protection, site filter fabric and stone base, paving of temporary construction entrance drive and temporary walks, temporary plating of the utility trench (refer to section 11, Site Logistics Plan). The scope of work detailed above will be completed prior to the start of construction. Any disruption, disassembly, temporary removal, damage, etc after commencement of construction should be coordinated with the construction manager and it will be the responsibility of the prime contractor responsible for the action to restore each item to its original condition.
4. All contractors must comply with Massaro Construction Management Services, LLC. (MCMS) Safety Program and OSHA regulations.
5. Each bid package will be responsible for project accounting in accordance with the Project Manual.
6. The successful Contractor is required to sign a Prime Contract for the scope of work detailed in the bid package, without exception.
7. Each Prime Contractor responsible for a bid package must review the LEED Requirements for the project and include necessary documentation and field related work as required.
8. All Prime Contractors must be pre-qualified by Massaro Construction Management Services, LLC.; you must be pre-qualified before bidding. See further information in this project manual in regards to pre-qualification.
9. All work is “furnish and install” unless otherwise noted. If marked “installation only”, that respective bid package is responsible for unloading, protecting, and inventory of that material. If marked “furnish only”, the Contractor is responsible for all sales tax and freight to the site unless it is tax exempt as defined in Section 9.
10. All MEP Prime Contractors are responsible for applying and paying for their permits.
11. Each bidder must bid on the entire bid package without exception. Any exclusion may subject the bidder to disqualification.
12. All contract documents are available for review and purchase via an online plan room. All bidders must register with Massaro CM Services to gain access to the plan room. Bidders
should call Tim Jones (tjones@massarocms.com) at Massaro CM Services at 412-963-2800. In addition, once registered, bidders will receive all project notifications via email.

13. Normal working hours will be from 7:00 am to 3:30 pm, unless noted otherwise. Any work performed outside these hours must be prior-approved by the Construction Manager.

14. All Fire Protection, Plumbing, HVAC and Electrical Contractor will be required to provide coordinated drawings for this project utilizing BIM per Section H5 of this project manual. The HVAC Contractor will be the "lead" Contractor in the coordination effort.

15. Parking is not permitted at the site. Each subcontractor is responsible for transportation and parking for their employees. Refer to Section F of this manual for more info.

16. Each Contractor is required to comply with the environmental protection and quality control requirements in the specifications.

17. A consistent, competent person for each subcontract will be responsible to attend a weekly subcontractors meeting.

18. All contractors will be responsible for cutting and patching required for their work unless otherwise noted and also fire proofing/fire stopping of their penetrations.

19. All on-site testing required by the specifications will be performed and paid by the prime contractor responsible for that work and coordinated through Massaro CM Services. Each bidder is responsible to coordinate, schedule, and accommodate testing as required. Fire Protection, Plumbing, HVAC and Electrical Contractors are also required to perform and pay for all testing and/or certification requirements related to their various systems, equipment and/or fixtures as specified and/or required by Local Agencies.

20. Each contractor is required to provide the following temporary utilities:
   a. His own drinking water.
   b. Ventilation and humidity control required for his own work prior to building enclosure.
   c. Extension for temporary utilities (water and electric) from those points where these utilities will be placed on site designated for this construction project.
   d. Additional temporary lighting required for specific activities required for their work.
   e. Telephone/Internet service in his own field office.
   f. Plug in power cords and other temporary electric distribution required for your work.
   g. Electric service power from electric meter to your own field office.
   h. Portable generators required for field welding required for your own work.
   i. Telephone/Internet service use charges required for his own field office.

21. Massaro Construction Management Services, LLC. must approve all field offices, trailers, storage facilities and materials stored on-site.

22. No material hoists will be provided by the Construction Manager. Any necessary hoist or rigging equipment is the responsibility of the Prime Contractor.

23. Each Prime Contractor is required to provide the following support facilities if the scope of work dictates such:
   a. His own field office, if required.
   b. Storage and fabrication sheds required for your work.
   c. Tools, materials, and equipment storage required for your work.
   d. Dewatering, pumping, or surface water control required for his own work.
   e. Daily cleaning and housekeeping services required for his own work, to
the onsite dumpster.

f. Lifts and hoists required for your work.
g. Temporary construction openings required for your work.
h. Temporary use of the permanent elevator (when available) required for your work. If a contractor would like to use the elevator to transport materials, the contractor will be responsible for protecting and operating the elevator. A temporary elevator will not be installed for this project.
i. Construction aids and miscellaneous services and facilities required for your work.

24. Each Prime Contractor is required to provide the following security and protection facilities as required for the work in your bid package:
   a. Mud control
   b. Fall protection required for specific activities
   c. Barricades, warning signs and lights
   d. Pedestrian safety
   e. Temporary enclosures, including site fencing, barricades and plating (Section F) required for any work outside of main site fence as detailed on logistics plan (Section H3)
   f. Noise control
   g. Dust and fume controls
   h. First aid supplies
   i. Temporary protection of your work product
   j. Temporary Protection of existing work the may be affected by your work
   k. Environmental protection required
   l. Traffic controls

25. Each Prime Contractor is responsible for its own clean up and a proportional amount of the general clean up. The General Trades Prime Contractor will provide a dumpster. Contractors who are delinquent in their clean-up effort will be charged accordingly.

26. Each Prime Contractor is responsible for the protection of its own installed work.

27. Each Prime Contractor is responsible for the layout of their work. The General Trades Prime Contractor will provide reference points and benchmarks.

28. Each Prime Contractor is responsible for their own fire stopping. The MEP/FP contractors will collectively pick one product so that the same product is used throughout the project.

29. The General Trades Prime Contractor will be responsible for building and site housekeeping pads for the mechanical and electrical equipment. Anchoring plates or bolts must be supplied to the General Trades Prime Contractor by the bid package from which this equipment is furnished.

30. You must comply with the most stringent standard when two or more standards or conflicting standards are within the bid documents.

31. This is a prevailing wage rate project requiring certified payrolls. See specifications Section D1 for information on minimum wage rates $/hr to be used.

32. A mandatory pre-installation meeting will be held by the Construction Manager prior to the start of each activity of work where the proposed foreman or competent personnel must attend. This may include multi-trade coordination. See Section A for additional information.

33. All contractors providing components of the building exterior envelope must fully participate in the development and assembly of mock ups, demonstrating the
34. A mock-up of the exterior wall will be required. Mock-up requirements are included in the exterior systems relevant spec sections.

35. Each bid package is responsible to fully review existing conditions that will affect their bid package.

36. Owner Furnished Contractor Installed (OFCI) and Owner Furnished and Owner Installed (OFOI) equipment includes but is not necessarily limited to the following:
   a. Chilled water meter installed by HVAC Contractor
   b. AV Systems equipment and distribution in rooms 017 Multipurpose Event Space, 022 Lecture Hall, 022A MTSS Tech Work/Storage observation, 102 Classroom, 102a Classroom, 115 Conference Room, 232 Conference Room, 218 Conference Room, 311 Conference Room, and 412 Conference Room will be furnished and installed by the Owner. Raceways and projector mounts required for this equipment are by Electrical Contractor.
   c. Relocation of bridge telecommunications feeding Henderson North is by PSU. General Trades contractor to install underground conduit, see site utility drawing.
   d. Chairs for Fixed Seminar Tables in Lecture Hall 022 will be furnished and installed by PSU, fixed seminar tables by General Trade Contractor.
   e. All head end equipment and electronics for telecommunication systems to be both provided and installed by PSU.
   f. All residential appliances on the project (refrigerators and microwaves etc) are to be both provided and installed by PSU.
   g. Main service transformer and primary side connection and conductors by PSU. Secondary side conductors furnished by Electrical Contractor, connections to main service transformer by PSU.
   h. Digital Multi-Meter is provided and installed by PSU.
   i. Elm wood supplied by PSU. All coordination, transportation to and from PSU, milling, fabrication and installation by General Trades contractor.
   j. Toilet accessories (Toilet Tissue dispensers, paper towel dispensers, soap dispensers and trash receptacles) furnished by PSU. Required coordination, blocking and installation by General Trades contractor.
   k. AV and Distance Learning Systems equipment and distribution in rooms 116 Conference/Classroom, 312 Conference Room and 419 Conference Room will be furnished and installed by the Owner. Raceways for equipment are by the Electrical Contractor.
   l. Flat screen monitors, installation brackets and distribution for Lobby F001, Lobby F104, Corridor Q102, Lobby F201, Lobby F301 and Lobby F401 to be furnished and installed by the Owner. Required coordination, blocking and support framework in Lobby F301 by General Trades contractor. Raceways required for this equipment are by the Electrical Contractor.

36. All bid packages are responsible to adhere to the Division 1-General Requirements specifications. They include:

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### DIVISION 1 - GENERAL REQUIREMENTS

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Bid Package 1 – HAZARDOUS BUILDING MATERIALS ABATEMENT DGS CONTRACT #800-290.HA1.1

Spec Sections:
Section H-6 of this Manuel
The Pennsylvania State University
Department of Environmental Health and Safety
Asbestos Containing Material Removal Performance Specification

1. Include abatement permit.
2. Inspect area to be abated.
3. All disposal of abated or demolished materials.
4. Selective demolition of fixed items encapsulating the asbestos, as required to accomplish your scope of work.
5. Temporary enclosures
6. Air monitoring and inspections will be by PSU. Refer to Section H6.
7. All asbestos abatement bidders must be prequalified by PSU. See requirements on OPP website at: http://www.opp.psu.edu/planning-construction/contractor-prequalification-information.

Bid Package 2 – BUILDING DEMOLITION, DGS CONTRACT #800-290.BD2.1

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1. Temporary protection of structures or items to remain.
2. Include termination of existing electric, water, gas, or other utilities that may be present with existing bridge building. Contractor will be required to cut, cap, and make safe.
3. Removal of all demolished materials from the project site. No demolished materials from this operation should be placed in the construction dumpsters provided by the General Trades Contractor.
4. Any permits related to this scope of work.
5. Separation, as required, for materials that can be reclaimed or recycled. Provide proper documentation of these materials by weight.
6. Include selective demolition of brick, to be stored on site, in a quantity required to patch the openings created by demolishing the connection bridge. The masonry contractor will be responsible for cleaning and placing the brick.
7. All structural / facility demolition bidders must be prequalified by PSU. See requirements on OPP website at: http://www.opp.psu.edu/planning-construction/contractor-prequalification-information.
8. PA DEP and US EPA Demolition Notifications - Demolition contractor, not general contractor, is responsible for completion and submittal. Draft forms are to be submitted
to PSU EHS for review and approval prior to mailing to appropriate regulatory agencies. After approval from EHS, the demolition contractor shall submit to appropriate agencies and provide signed copies to EHS the same day, with proof-of-mailing. Demolition shall not begin until 10-working days after the approved notification is post-marked.

9. Demolition contractor is responsible for wetting debris from time of first contact until placing into appropriate waste or hauling containers or trucks. Debris shall not be allowed to dry before removal from site. Visible airborne dust is not permitted.

10. Demolition contractor is responsible for providing water tank / pump trucks if on-site water flow or pressure is not sufficient for operations.

11. Every effort has been made to identify and remove all asbestos from the facility prior to demolition. If suspect asbestos is discovered cease operations and notify OPP and EHS immediately.

12. If unusual stains or odors are detected in soils, cease demolition or excavation operations and notify OPP and EHS immediately.

13. All painted CMU, brick or concrete must be disposed as demolition debris at a PA DEP licensed landfill. These materials contain lead-based paint and cannot be reused at PSU or any other non-PSU sites.

14. Salvage of painted materials such as doors, windows, frames, moldings, etc. must be coordinated with EHS. End users of these materials must be provided with a Lead Paint Notification / Disclaimer before removing from PSU property.

15. Demolition contractor is responsible for building demolition in its entirety including any content left by owner inside building.

Bid Package 3 – GENERAL TRADES, DGS CONTRACT #800-290.GC3.1

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**DGS 800-290/PSU 06-42744/BCJ 08001**
**12 November 2010**
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1. Architectural masonry finishes including mock ups as required. Mock-up construction and approval process will commence directly following notice to proceed. Mock-ups will be required for but not necessarily limited to match both the Henderson North existing unit masonry, stone masonry and mortar and the Henderson South mortar (bridge infill only – harvested brick from bridge building demo). Refer to specification sections for further details. The review and selection process will be thorough and may involve multiple iterations.

2. Furnish and install sealers and hardeners as specified and on the finish schedule.

3. Include vapor barrier under slab on grade as specified.

4. Include winter/ inclement weather provisions as required by the construction schedule.

5. Grout leveling plates, beam pockets, elevator seals, or other items.

6. Install anchor bolts and any other embedded items supplied by Structural and Misc. Steel bid package.

7. Set and grout any bollards.

8. Furnish and install all reinforcing steel embedded in your concrete.

9. Dewatering as required to accommodate your operation.

10. This package is responsible for transformer pads, sidewalks, curbs, generator pads, or any other MEP Pads including reinforcement.

11. Review slab elevations to verify recessed slabs to accommodate floor finishes.

12. Coordination with the waterproofing contractor and MEP’s for horizontal waterproofing membrane, penetrations, and finishes at exterior plaza above the auditorium.

13. All waterproofing membranes will be furnished and installed by General Trades Contractor.

14. Infill of metal pan stairs and placement of stair nosing’s if required.

15. Include any add mixtures per the specifications and to meet you means and methods.

16. The General Trades Contractor will include all joint sealants for this project.

17. It is assumed footings will need to be formed.

18. Furnish and install any cavity wall insulation, flashings, and waterproofing membrane in the cavity wall.

19. Set all lintels.

20. All flashings required for your work.

21. Furnish and Install all reinforcing steel with your scope of work including any welding that may be required.

22. Grout masonry door frames.

23. Furnish and install all masonry anchors required by your scope of working including any welding that may be required.

24. Interior brick and limestone walls including benches and interior stone flooring.

25. All equipment required for off loading and erection including welding must be included in this bid package.

26. Include BIM as a part of this bid package in accordance with Section H5 of this
27. Special coatings as specified.
28. Pour stops at all edge of slab conditions.
29. Furnish and install all anchor bolts, base plates, embedded steel, temporary edge protection, railing sleeves, and provide final anchor bolt plan noting any deviations from the construction documents.
30. Furnish and install perimeter fall protection cables as required by OSHA including, but not limited to the perimeter of the building at the floors, shafts, elevators, and stairs. Maintain while on site and include final removal.
31. Verify the need for primed steel vs. fireproofing requirements.
32. Include all steel that is welded or bolted to the structural steel.
33. Include elevator sill angles, hoist, rail, and divider beams.
34. Include all site and building guard, and hand rails. This is a performance specification item and will require a licensed structural engineer’s sign and seal.
35. Furnish and install all lintels.
36. Include all steel exposed to the elements to be galvanized unless noted otherwise in the contract documents. This is a performance specification item and will require a licensed structural engineer’s sign and seal.
37. Furnish and install all ladders. This is a performance specification item and will require a licensed structural engineer’s sign and seal.
38. Foundation wall waterproofing and insulation/drainage board.
39. Elevator pit waterproofing
40. Flashing required at transitions and wall penetrations.
41. Wood sheathing and dimensional lumber are by General Trades Package.
42. All blocking for roof accessories are by the General Trades Contractor.
43. Include flashing at all MEP curbs, drains, vents or other penetrations.
44. Horizontal and vertical insulation under your roofing systems as specified.
45. All flashings, expansion, scuppers, spout, trims, copings, riglets, or accessories required for you scope of work.
46. Furnish and install fire rated shutters including coordination with the fire alarm system provider.
47. Include hardware required for proper operation.
48. Include exterior caulking for all work in the bid package.
49. Include coordination with the electrician for distribution and termination of cable for door hardware.
50. Any glass or mirrors in casework to be furnished and installed by General Trades Contractor.
51. Any door operators will be furnished and installed by this bid package including low volt wiring. Power to the units is the responsibility of the electrical contractor.
52. Include all gypsum based sheathing, wood sheathing and blocking within your scope of work.
53. Linear and panel wood ceiling systems.
54. All suspended acoustical ceiling systems.
55. Wall and ceiling expansion joint assemblies.
56. Tile backer board, as required.
57. Waterproofing/crack suppression membrane per the specifications.
58. Stone flooring.
59. Interior limestone benches, wall wainscot, and brick walls.
60. Thresholds or transitions as required.
61. Floor mats and frames will be furnished and installed with this bid package.
62. Provide flooring for elevators, as required.
63. Machine Roomless Elevator, General Trades contractor will provide complete elevator package including all wiring from elevator to disconnects in elevator machine room.

64. Include one set of wall protection cloths per cab.

65. Include coordination with other life safety trades as required.

66. Obtaining Labor and Industry approvals.

67. Install and maintains E&S for the duration of the project. Removal by others.

68. Stone bedding of the project site as noted in the construction documents will be provided by Construction Manager and removed by the General Trades contractor.

69. Perimeter construction fencing, temporary fence lighting and tree protection fencing will be installed and removed by Construction Manager. These items will be maintained by the General Trades Contractor for the duration of the project.

70. This package is responsible for installation of shoring. As a part of the backfilling operation remove the top 4’ of the temporary shoring system.

71. All site paving, sidewalk, and curb demolition as indicated on the construction documents.

72. All site signage is by General Trades Contractor. Temporary safety or protection signage and fence at trenches are the responsibility of the subcontractor creating the trenches.

73. Include all mass and structural excavation as required. All excavation spoils to be hauled to an offsite location. Obtain any regulatory approvals required for any offsite spoils removal.

74. Rock excavation is unclassified.

75. Include foundation backfill with foundation drainage system.

76. Include two well points in the excavation to be maintained under this subcontract until the foundations are completed.

77. This bid package will be responsible for street cleaning for the project duration.

78. Establishing rough grade is the responsibility of this package. The landscaping contractor is responsible to spread the stockpiled topsoil and complete the seeding.

79. Furnish and install all stone subbase for site and building concrete.

80. Include all asphalt paving, subbase, and line stripping.

81. Include snow removal from the construction roadways, staging area, building entrances, and job trailers for the project duration. Stockpiling of snow on site will not be permitted.

82. Spoils created by temporary shoring operation.

83. Stockpile topsoil on site at designated location. The General Trades Contractor will be responsible to provide all topsoil need for this project. If the estimated top soil on site for stockpiling does not meet the need for completing the project the General Trades Contractor will be required to furnish additional topsoil to complete the project. Any imported topsoil will need to meet the requirements of the contract documents for topsoil.

84. Include all site demolition and restoration as required for your work.

85. Include stone backfill to subgrade for all utilities under paved walk or drive areas.

86. Site lighting will be installed by the electrician in it’s entirety including, but not limited to trenching and backfill, conduit, pole bases, poles, and fixtures.

87. Include concrete encased ductbanks as noted on the construction documents for all tele/data/communications and electrical utilities. Include pull strings as required for the electrical subcontractor to pull required cable.

88. The General Trades Contractor will furnish and install all access panels for this
project. Location and sizes to be coordinated between trades with final approval for both location and size by Project Architect and Construction Manager.

89. General Trades Contractor is responsible to furnish and install Site Furnishings including handrails, vehicular bollards and pedestrian bollards-post and chain.

90. Shoring piles must be predrilled to mitigate potential damage to adjacent structures and utilities.

91. It is our opinion that tie-backs will not be an option due to the relatively close proximity to existing structures, new and proposed utilities. Please do not include tie-backs as a part of your design. Please notify CM prior to deadline for RFI's if this poses any issues in the design.

92. Responsible for design and adequacy of the shoring.

93. The General Trades Contractor will tie into the building storm, sanitary, water and gas within 5’ of the building perimeter and the tie-in will be part of this scope of work. Locations to be coordinated during construction.

94. The General Trades Contractor will be required to stub all steam, condensate and chilled water piping into the building 1’ and provide a flanged connection for the HVAC Contractor. All sleeves and seals/gaskets for this work to be furnished and installed by the General Trades Contractor.

95. The General Trades Contractor shall include; engineering of steel connections and performance specified items for reactions shown on drawings, engineering and coordination of all stone supports, engineering of site walls/site stairs/waterstops in concrete and all coordination/engineering requirements/responsibilities associated with the building structure.

96. The General Trades Contractor shall furnish and install all site walls, limestone steps/seatwalls, paving (concrete, brick and granite) curbs, sidewalks, asphalt paving, site concrete stairs, site caulking, site painting and protection of existing field stone wall as required by the contract documents.

97. The General Trades Contractor should coordinate the location of all sleeves, openings, depression locations and sizes with other trades.

98. This bid package is responsible for the demolition (including cut, cap & make safe) of existing site utilities outside of bridge building, and coordination, trenching, backfill, piping, and structures for the following new systems:
   a. Storm and storm retention
   b. Sanitary sewer
   c. Water
   d. Gas
   e. Steam and condensate
   f. Chilled water
   g. Electrical primary and secondary ductbank
   h. Tele/data/communications
   i. Temporary utility relocations (includes but not limited to, natural gas & telecom conduit feeding Henderson North)
   j. Existing site steam tunnel restoration & repairs (ref dwg. C8.11) and temporary protection
   k. Two (2) 12” schedule 80 PVC raceways and handholes for stage feeds w/ pull string (reference drawing C5.02),
   l. Irrigation storm overflow from cistern, outflow and rain water filters
   m. All manholes, vaults, trenches, tunnels, inlets and sumps associated with site utilities

99. General Trades contractor owns all infill and restoration (including but not limited to masonry, windows, structural, joint sealants, flashing, doors and partitions) after demolition of bridge building in Henderson North and South as shown on
the Architectural Demolition drawings. Coordinate with Demolition contractor for salvaged masonry. This work to also include insulated, temporary infill and any Signage required.

100. General Trades contractor to coordinate with the University and the Construction Manager for the procurement and use of existing Elmwood as indicated on the architectural drawings and detailed in the specifications.

101. Per RFI PC133 - Site Utilities including water are by the General Trades Contractor. The General Trades Contractor should plan directly after contract award to complete installation of the water main 10"x 10"x 8" tee off the existing 10" line (see C5.02) along with the shut off valve. At the time of this installation a water meter should be installed for temporary water for contraction and the tire wash. The feed for the tire was should be installed underground by the General Trades Contractor. The routing (from the meter set) would be underground south to the the steam tunnel, (penetrate the steam tunnel and temp. seal the penetration) once in the steam tunnel run the line east in the tunnel to the location of the temporary truck wash (see Logistic Plan, Section H3, page 3, south east of the new building). Once again penetrate the steam tunnel for use at the truck wash. Truck wash piping inside the steam trench should be continuous (PEX type) or soldered copper and heat resistant to the temperatures inside the steam trench. The General Trades Contractor should protect the water meter and associated piping from freezing and damage from construction. All truck wash piping will be removed at the end of the project and trench penetrations patched by the General Trades Contractor. [C]

Bid Package 4 – FIRE PROTECTION SYSTEM, DGS CONTRACT #800-290.5

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1. The Fire Protection Prime Contractor is responsible for all piping for the fire protection system in the building from the point of connection at the water service.
2. Include BIM as a part of this bid package in accordance with Section H5 of this Project Manual.
3. NFPA 13 design standards.
4. Permits and fees required for your scope of work.
5. Flow test
6. Submission of sealed design drawings and calculations to the approving agencies and prior to submission to Massaro Corporation and owner’s insurance company.
7. Site fire protection utilities or fire hydrants by other.
8. Include all firestopping for your work.
9. The General Trades Contractor will furnish and install all access panels for this project. Location and sizes to be coordinated between trades with final approval for both location and size by Project Architect and Construction Manager.
10. Full coordination with the electrical contractor as well as detailed device and system drawings to clearly define the devices to be wired by the Electrical bid package.
11. Site and building concrete equipment pads are to be completed by others.
Bid Package 5 – PLUMBING. **DGS CONTRACT #800-290.3 [C]**

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1. Site water, sanitary, storm, and gas utilities are a part of General Trades bid package. HVAC/Plumbing bidders interested in this scope of work are encouraged to submit on the site utilities package as well.
2. Include BIM as a part of this bid package in accordance with Section H5 of this Project Manual.
3. Permits and fees required for your scope of work.
4. Plumbing Prime Contractor will extend all storm, sanitary, gas, and water piping to a minimum of 5’ outside the building perimeter including sleeves and seals/gasketing to make the building water tight. Final Location to be coordinated during construction.
5. Include all firestopping for your work.
6. The General Trades Contractor will furnish and install all access panels for this project. Location and sizes to be coordinated between trades with final approval for both location and size by Project Architect and Construction Manager.
7. The Plumbing Prime Contractor is responsible to provide dedicated, valved stub piping with backflow prevention off main piping (sized correctly) inside the building mechanical room for all irrigation and water feature feeds. Location will be coordinated during construction.
8. Site and building concrete equipment pads are to be completed by others.
9. Full coordination with the electrical contractor as well as detailed device and system drawings to clearly define the devices to be wired by the Electrical bid package.
10. *Deleted text. [C]*
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<td>UNIT HEATERS</td>
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<tr>
<td>25 55 00</td>
<td>BUILDING AUTOMATION SYSTEMS</td>
</tr>
</tbody>
</table>

1. The HVAC Prime Contractor will tie into a flanged connection stubbed either through the wall or floor for connection of the building mechanical piping systems. Site steam and condensate, and chilled water utilities are a part of General Trades bid package.
2. Include BIM as a part of this bid package in accordance with Section H5 of this Project Manual.
3. Permits and fees required for your scope of work.
4. Include all firestopping for your work.

5. The General Trades Contractor will furnish and install all access panels for this project. Location and sizes to be coordinated between trades with final approval for both location and size by Project Architect and Construction Manager.

6. Include ATC/BAS requirements provided by either Automated Logic (Pittsburgh) or Johnson Controls (Harrisburg).

7. Include all louvers and vents whether mechanical or not. The intent is to have all interior and exterior grills, louvers and vents come from the same supplier/manufacturer.

8. Furnish and install all rooftop curbs. Coordinate locations with steel fabricator and roofing contractor.

9. Site and building concrete equipment pads are to be completed by others.

10. Full coordination with the electrical contractor as well as detailed device and system drawings to clearly define the devices to be wired by the Electrical bid package.

11. The HVAC prime contractor is responsible for locating and installing all duct smoke detectors. Duct detectors provided by others.

Bid Package 7 – ELECTRICAL, DGS CONTRACT #800-290.EL1.4

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>07 84 13</td>
<td>PENETRATION FIRESTOPPING (For your work)</td>
</tr>
<tr>
<td>08 31 13</td>
<td>ACCESS DOORS AND FRAMES</td>
</tr>
<tr>
<td>12 93 00</td>
<td>SITE FURNISHINGS</td>
</tr>
<tr>
<td>26 05 13</td>
<td>MEDIUM-VOLTAGE CABLES</td>
</tr>
<tr>
<td>26 05 19</td>
<td>LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES</td>
</tr>
<tr>
<td>26 05 26</td>
<td>GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS</td>
</tr>
<tr>
<td>26 05 29</td>
<td>HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS</td>
</tr>
<tr>
<td>26 05 33</td>
<td>RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS</td>
</tr>
<tr>
<td>26 05 44</td>
<td>SLEEVES AND SLEEVE SEALS</td>
</tr>
<tr>
<td>26 05 53</td>
<td>IDENTIFICATION FOR ELECTRICAL SYSTEMS</td>
</tr>
<tr>
<td>26 05 73</td>
<td>OVERCURRENT PROTECTIVE DEVICE COORDINATION</td>
</tr>
<tr>
<td>26 08 00</td>
<td>ELECTRICAL SYSTEM COMMISSIONING</td>
</tr>
<tr>
<td>26 09 23</td>
<td>LIGHTING CONTROL DEVICES</td>
</tr>
<tr>
<td>26 09 43</td>
<td>NETWORK LIGHTING CONTROLS</td>
</tr>
<tr>
<td>26 12 00</td>
<td>MEDIUM-VOLTAGE TRANSFORMERS</td>
</tr>
<tr>
<td>26 13 00</td>
<td>MEDIUM-VOLTAGE SWITCHGEAR</td>
</tr>
<tr>
<td>26 22 00</td>
<td>LOW-VOLTAGE TRANSFORMERS</td>
</tr>
<tr>
<td>26 24 13</td>
<td>SWITCHBOARDS</td>
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<td>26 24 16</td>
<td>PANELBOARDS</td>
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<tr>
<td>26 27 26</td>
<td>WIRING DEVICES</td>
</tr>
<tr>
<td>26 28 13</td>
<td>FUSES</td>
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<tr>
<td>26 28 16</td>
<td>ENCLOSED SWITCHES AND CIRCUIT BREAKERS</td>
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<tr>
<td>26 29 13</td>
<td>ENCLOSED CONTROLLERS</td>
</tr>
<tr>
<td>26 29 23</td>
<td>VARIABLE-FREQUENCY MOTOR CONTROLLERS</td>
</tr>
<tr>
<td>26 36 00</td>
<td>TRANSFER SWITCHES</td>
</tr>
</tbody>
</table>
1. Site electrical and tele/data utilities are a part of General Trades bid package and include trench, backfill, compaction, spacers, conduits, pull strings, concrete encasement, warning tape, etc. It is the responsibility of the Electrical Contractor to coordinate locations with the General Trades utility subcontractor and to furnish, install and pull all wire and cable, provide all testing and make final terminations as required. It is also the Electrical Contractor’s responsibility to install the secondary feeds from transformer to building with terminations inside building. PSU to provide and install transformer and primary feed. All terminations at transformer by PSU. Electrical contractors responsibility to provide all conduit, wiring sleeves, seals from transformer to building main electrical room. The building transformer will be provided by others.

2. This bid package is responsible for the entire exterior lighting system including, but not limited to, trenching, backfilling, conduit, concrete pole bases, all site fixtures and all site wall fixtures. Coordination between the Electrical Contractor, General Trades Contractor and Landscape Contractor will be required for installation of the site lighting.

3. Include BIM as a part of this bid package in accordance with Section H5 of this Project Manual.

4. Permits and fees required for your scope of work.

5. Include all firestopping for your work.

6. The General Trades Contractor will furnish and install all access panels for this project. Location and sizes to be coordinated between trades with final approval for both location and size by Project Architect and Construction Manager.

7. Include temporary lighting of the building in accordance with PA UCC and OSHA requirements. This lighting will remain the property of the electrical subcontractor once the permanent lighting is operational. All temporary lighting and feeds must be removed from building once permanent system is operational.

8. Include temporary electrical service including transformer and distribution of a 480 volt, three phase service from a point shown on the site plans. Extension of this service to one (1) 200 amp sub-panel per floor with 120 volt quadplex receptacles located throughout the floors per OSHA Standards.

9. Electrical Prime Contractor will be responsible to remove all existing site lighting and make safe. Return the light fixtures and poles back to PSU for storage. Below grade demolition of conduit, if required, will be by the General Trades Contractor.

10. Site and building concrete equipment pads are to be completed by others.

11. This bid package is responsible to furnish and install Site Furnishings including, emergency call box including all electrical and voice/data/security requirements.

12. Electrical Prime Contractor will furnish and install all Telecommunications raceways, conduit, sleeves, boxes and cable trays for the installation of the Telecommunications cabling. All miscellaneous hangers and supports should be furnished and installed by the Telecommunication Prime Contractor.
13. Electrical Prime Contractor should furnish and install 120V power, grounding, ground bars and back boards for all Telecommunications equipment. Cabling and final connections for all Telecommunications equipments is by Telecommunications contractor.

14. Stage power supply shown on L3.1 and L4.3 will be provided and installed by electrical contractor including panel boards, raceways, cabling, devices and terminations. Coordinate with general trades contractor. Wall, screen and Neenah trench with cover by general trades contractor.

15. Electrical prime contractor to provide and wire all duct smoke detectors. Installation by HVAC contractor.

16. Electrical Prime Contractor to provide elevator disconnects including shunt, feeds to disconnects and final connections in elevator machine room.

17. Electrical Prime Contractor is responsible for the reacceptance testing and rerouting of the fire alarm system due to bridge demolition. Coordinate with PSU/ MCMS.

Bid Package 8 – TELECOMMUNICATIONS (Low Voltage Systems), DGS CONTRACT #800-290.TL2.4

Spec Sections:

<table>
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<th>Section</th>
<th>Description</th>
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<td>26 05 19</td>
<td>LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (For your work)</td>
</tr>
<tr>
<td>26 05 29</td>
<td>HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS (For your work)</td>
</tr>
<tr>
<td>26 05 44</td>
<td>SLEEVES AND SLEEVE SEALS</td>
</tr>
<tr>
<td>26 05 53</td>
<td>IDENTIFICATION FOR ELECTRICAL SYSTEMS (For your work)</td>
</tr>
<tr>
<td>26 08 00</td>
<td>ELECTRICAL SYSTEM COMMISSIONING (For your work)</td>
</tr>
<tr>
<td>26 27 26</td>
<td>WIRING DEVICES (For your work)</td>
</tr>
<tr>
<td>27 05 36</td>
<td>CABLE TRAYS FOR COMMUNICATIONS SYSTEMS (for your work)</td>
</tr>
<tr>
<td>27 15 00</td>
<td>COMMUNICATIONS HORIZONTAL CABLELING</td>
</tr>
</tbody>
</table>

1. Raceways, conduit, sleeves, boxes and cable trays for the Telecommunications cabling will be furnished and installed by others. All miscellaneous hangers and supports should be furnished and installed by the Telecommunication Prime Contractor for completion of the work associated with this bid package.

2. Telecommunications contractor should furnish and install sleeve seals as detailed in the contract documents.

3. 120V power, grounding, ground bars and back boards for all Telecommunications equipment is by others. Telecommunications contractor will make all final connections to equipment provided under this section.

4. The General Trades Prime Contractor will furnish and install the site telecom conduits as detailed on site utility drawings. The Telecommunications Prime Contractor will be responsible to furnish and install all site cabling from the existing building to the main telecom room inside the new building.

5. Telecommunications Prime Contractor will furnish and install all tele/data and cable TV cabling including terminations, devices, equipment, racks, patch panels and complete punch-down as detailed in contract documents.

6. Telecommunications Prime Contractor to coordinate all installations with the Constructions Manager and Owner.
7. The General Trades Contractor will furnish and install all access panels for this project. Location and sizes to be coordinated between trades with final approval for both location and size by Project Architect and Construction Manager.

8. Include BIM as a part of this bid package in accordance with Section H5 of this Project Manual.

9. All Telecommunication bidders must be prequalified by PSU. See requirements on OPP website at: [http://www.opp.psu.edu/planning-construction/contractor-prequalification-information](http://www.opp.psu.edu/planning-construction/contractor-prequalification-information).

Bid Package 9 – LANDSCAPING, DGS CONTRACT #800-290.LA4.1

Spec Sections:

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<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>12 93 00</td>
<td>SITE FURNISHINGS</td>
</tr>
<tr>
<td>22 52 00</td>
<td>WATER FEATURE MECHANICAL SYSTEM</td>
</tr>
<tr>
<td>31 22 19</td>
<td>FINISH GRADING</td>
</tr>
<tr>
<td>32 84 00</td>
<td>IRRIGATION SYSTEM</td>
</tr>
<tr>
<td>32 91 00</td>
<td>PLANTING SOILS</td>
</tr>
<tr>
<td>32 92 00</td>
<td>TURFS AND GRASSES</td>
</tr>
<tr>
<td>32 93 00</td>
<td>EXTERIOR PLANTINGS</td>
</tr>
<tr>
<td>32 95 00</td>
<td>ROOF GARDEN LANDSCAPING</td>
</tr>
<tr>
<td>32 95 10</td>
<td>LAWN TERRACE ROOF ASSEMBLY (For coordination)</td>
</tr>
</tbody>
</table>


2. Install topsoil stockpiled on site and finish grade soils to meet requirements of contract documents. The General Trades Contractor is to initially stockpile topsoil and make-up any shortage. The Landscape Prime Contractor will spread from the stockpile throughout the site.

3. Include seeding as specified.

4. Furnish and install roof garden soil and plantings as required including the grade level plaza above the auditorium and elevated roofs. This package is responsible for hoisting or conveying of those materials. The roof system supplier must approve the green roof components by others so that the roofing warranty requirements are met.

5. Furnish and install the complete irrigation system as indicated on the construction documents (including cistern, rainwater filters and all other interconnecting piping and diverter). The Plumbing Prime Contractor will provide dedicated, valved, stubs with backflow prevention off the main water line in the mechanical room. It will be the responsibility of the Landscaping Contractor to complete the irrigation system in its entirety from the stub in mechanical room including all piping, fittings, insulation, hangers, controller, heads, trenching, backfill and protection of system for the duration of the project. The Landscape Contractor will also be responsible for piping and connection to the storm piping since the primary irrigation water will be grey water from the roofs (potable water is the back-up system). Location for storm piping connection must be coordinated with Plumbing Contractor / General Trades Contractor and approved by Architect.

6. Site Pavers furnished and installed by others.

7. Landscaping Contractor is responsible to furnish and install Site Furnishings including benches, seating and tables, bicycle racks and trash receptacles.

8. Landscaping Contractor to furnish and install water fountain/feature in its entirety as detailed on contract documents including all feeds, tie-in and final connections.

9. Include lawn and plant maintenance as specified.

10. Landscape Prime Contractor will be required to submit unit pricing (within 30 days of receiving a contract) for plant material type and size to the Construction Manager.

END OF SECTION
SECTION H1 – GENERAL SCOPE OF THE WORK

GENERAL SCOPE OF THE WORK

1. This Contractor understands that this project has LEED Certification requirements and will comply with all requirements of the LEED Program as established by the Architect.

   a. The General Trades Contractor will provide a trash chute for debris removal that will serve the 2nd, 3rd and 4th floors of the new building.

   b. The General Trades Contractor will also provide all debris dumpsters for the duration of the project. All debris both construction and otherwise will require sorting and documentation to satisfy the LEED requirements.

   c. Dumpsters supplied by the General Trades Contractor should be general purpose dumpsters with LEED sorting taking place at a facility off site. No more than two dumpsters will be permitted on site at any given time. Rotation must happen in a timely manner so as to not delay debris removal from the building. Dumpster rotation should be coordinated with the Construction Manager. All dumpster receipts detailing specific debris contents as required by LEED should be submitted weekly to the Construction Manager.

2. This Contractor understands that this project is NOT an Owner Controlled Insurance Program (OCIP).

3. This Contractor understands that Pennsylvania Prevailing Wage Scale is a requirement of the Contract and has thoroughly reviewed and has included the current prevailing wage rates and the daily Submissions of certified payroll. (See Section D1 – Prevailing Wage Requirements)

4. If the Contractor shall fail to properly perform its work in a timely manner as a result of which the completion of the Project is delayed, Contractor shall also reimburse Massaro CM Services, LLC (MCMS) for any and all liquidated damages that may be assessed against Massaro CM Services, LLC. Massaro CM Services, LLC shall have the right to apportion such liquidated damages among Contractor and any other Contractor or other parties responsible for such delays whether or not concurrent or consecutive.

5. The Contractor has carefully examined the drawings, read the specifications and all other contract documents and visited the site of the work. The Contractor has fully informed himself/herself as to all existing conditions and limitations under which the work is to be performed and included a sum to cover all costs of all items necessary to perform the work as set forth in the contract documents. No allowance will be made to any Contractor because of lack of such examination or knowledge. The execution of this contract is construed as conclusive evidence that the trade contractor has made such examinations.

6. Adhere to The Pennsylvania State University guidelines and procedures addressed in PSU’s “Initial Job Conference Guide” package.

7. In the event of discrepancies or differences between bid documents/governing authority regulations/building codes, standards, etc., the more stringent requirement shall apply. (example: if the bid documents call for a specific type of electrical device but the latest edition of the applicable electrical code for this project calls for an enhanced device, the enhanced device should be supplied)

8. After bids are received, contractors will need to attend a scope review meeting with Massaro CM Services, LLC, the Owner, and the Architect.
9. Each contractor, upon award, is to forward a schedule of values for each individual item of work, in s.f. or l.f. costs for accounting daily.

10. The safety of the University’s construction personnel, employees, students, faculty and visitors is of the highest level of importance to PSU and Massaro CM Services, LLC. There will be zero tolerance for trades people that do not respect behavior and safety rules to allow for a good working environment. Contractor understands that their employees will be required to participate in the PSU/MCMS safety program, including 1st day orientation, weekly safety meetings and maintaining safe work practices. Contractor shall take protective measures necessary for the safety of workmen, the public, and adjacent property. All safety measures shall comply with the regulations of all State and Local authorities having jurisdiction, including all applicable OSHA requirements, MCMS Safety Rules, PSU Project Safety Plan and at MCMS’s direction. Contractor shall abide by all current regulations and procedures regarding Confined Space Safety Practices and Fall Protection. Employee’s failure to comply with safety and good behavior on site will ultimately result in expulsions from project. Each Contractor will be required to designate in writing an on-site safety representative. Progress payments cannot be released until MCMS has received this letter. This Contractor will be required to submit MCMS a copy of their site specific Safety Program.

11. This Contractor’s equipment that operates by internal combustion and is on site for more than a one-week period shall be equipped with an exhaust scrubber to reduce emissions and muffler to minimize noise.

12. Jobsite security and security of materials is the responsibility of the Contractor, not MCMS.

13. All openings created by this Contractor shall be this Contractor’s responsibility to protect and maintain same with OSHA approved protection until closed in or permanent protection has been installed. Temporary barricades shall be placed and maintained by the Contractor creating the hazard, or when necessary to facilitate the next sequence of construction. The Contractor responsible for the next sequence of construction is then responsible for the barricades (and the ultimate removal of same) if a hazard still exists. The Contractor who disturbs barricades shall restore them to meet safety requirements, at their own expense. The “barricades” applies equally to all safety, weather, and dust protection provisions. MCMS shall have the right to determine the suitability of barricades.

14. This Contractor will abide by all traffic restrictions set forth by the Owner. There will be no parking available on site for Contractors. Parking will be available at a designated parking lot on the PSU campus. This Contractor will be responsible for parking permit costs and shuttling employees from the designated parking lot to the jobsite.

15. Applications for payment shall be submitted to MCMS no later than the 24th of each month. Payment will be for work in place by the end of the month, and should be projected to reflect this.

16. Each Prime Contractor must have a line item in their invoice “schedule of values” that allows 3% of the total contract amount for close-out documents (as-builts, warranties, operations and maintenance manuals, punch-lists, etc.).

17. Drinking water facilities will not be provided by MCMS. All contractors are to provide for their employees.

18. Provide all submittals including, but not necessarily limited shop drawings, catalog cuts, samples and record drawings in accordance with the specifications. All LEED documentation should be submitted as part of the initial submittal. Contractor shall first review each submission, make changes or notations as necessary to conform to contract documents directly on the shop drawings, identify such review with an approval stamp, and forward to
Massaro CM Services. Massaro CM Services will not review any shop drawings not reviewed by and bearing the contractor’s approval stamp, signature, and date. Electronic submission will be a requirement of this project. The electronic submittals (in .pdf format) will be submitted via Massaro CM Services’ Prolog Converge website. All primes will be provided user accounts for Prolog Converge. Contractor will provide four (4) copies of field use drawings to Massaro CM Services after approval. All primes are responsible for the printing of any hard copies needed for their field personnel.

19. All submittals shall be submitted no later than 4 weeks from the date of award unless otherwise stated.

20. Furnish attic stock as required by the drawings, specifications, or the scope of work.

21. MCMS will not provide jobsite office/storage trailers, nor utilities for the same. Contractors will not be permitted to use MCMS’s or the Owner’s phones.

22. Notify MCMS of any major deliveries at least five (5) days prior to said delivery.

23. Should this Contractor need to work on off hours to maintain contract schedule or cause another Contractor to work off hours which requires standee personnel (including MCMS and Contractor’s), this Contractor will be responsible for cost of same. If this Contractor fails to complete their work per the schedule time allotted and this delay causes the overall project schedule to be delayed, this contractor will be responsible for any impact cost or liquidated damages.

24. This Contractor has included all rigging, hoisting and stocking of materials and removing debris as required to complete their work and so as not to interfere with the Construction Operation. Any rigging or hoisting over occupied areas must be scheduled at least two (2) weeks in advance and is subject to MCMS’s approval. No lifting over any areas which are occupied by the construction employees, visitors, guests, etc., will be allowed at any time.

25. Scaffolding, lifts, cranes, and other means of access for own work are the responsibility of the Contractor unless specifically excluded in the subcontract. Basic access to the site will be provided. Do not overload roofs or floors.

26. As built record drawings as well as operating and maintenance manuals shall be assembled by this Contractor and submitted in accordance with the specifications. In addition, to what is required by the specifications all close out and as built documents are to be submitted in electronic form (“pdf” format for 11” x 17” documents or smaller and CADD for drawings).

27. Provide any and all precautionary measures required to protect your work and other adjacent work against damage. The cost to repair any damage (to existing or new) finishes will be split among all contractors working in that area unless specific contractors can be identified. Temporary Construction Fence will be provided by others. This Contractor will be responsible to relocate and re-install the construction fence as necessary to complete their work and must notify MCMS 48 hours prior to commencement of work.

28. This Contractor shall have an office representative (not only a foreman or project superintendent) attend MCMS’s weekly progress meeting. It is suggested that the Field Foreman also attend to assist the office representative and aid in communication during the meeting. Contractors will be required to attend the progress meetings two (2) weeks prior to their work commencing, during the duration of their work and two (2) weeks after their work is substantially complete. Contractor’s representatives are required to be on time and remain until the meeting has been concluded by MCMS. Contractor will be held responsible for the outcome of the meeting whether in attendance or not. Any Contractor not in attendance or not present for the entire meeting will be charged $100.00 per occurrence which will be
deducted from their contract amount. All Contractors performing work on the project are also
required to attend the weekly progress meetings as defined above. The representatives to
the meeting are expected to make commitments with regard to schedule and cost during the
construction process. Contractor shall maintain on-site supervisory personnel capable of
making construction changes as needed, attending foreman’s meetings, and having a
complete understanding of the requirements of the job.

29. This Contractor will perform all engineering and layout required for this Contractor’s work.
The Owner will provide vertical control (benchmarks) and horizontal control (building center
lines). The Contractor shall perform all other vertical/horizontal control required to complete
their scope of work.

30. Time is of the essences on this project. Contractor is responsible for all efforts, methods,
procedures, and cost to meet or better the project schedule dates. This Contractor has
included shift and/or premium time as required to maintain the project schedule. Provide all
necessary remobilizations to complete their scope of work.

31. MSDS are required to be on file with MCMS prior to commencing any fieldwork. It is this
Contractor’s responsibility to keep current all MSDS and inform tradesmen of the location of
same. All MSDS will be on file in MCMS’s jobsite office and Contractor’s office.

32. Pricing for additional work or credits shall be submitted within one (1) week unless it is judged
by MCMS to be a major revision for which MCMS will establish the due date. If pricing is not
submitted as stated above, then MCMS may submit an estimate for this Contractor on their
behalf. If the overall Pricing is accepted by the Owner, then this Contractor’s price for that
work will not exceed MCMS’s estimate.

33. All change order pricing must be accompanied by a labor and material breakdown and with
Contractor and Vendor quotes.

34. Normal working hours shall be 7:30 a.m. to 3:30 p.m. unless otherwise directed by MCMS.
This Contractor understands that this project site is adjacent to other campus buildings and
noise, dust and behavior control are of the highest importance to PSU and MCMS.

35. This Contractor shall provide a minimum of one (1) year warranty unless specified as
elsewhere in the contract documents.

36. Independent quality testing and inspections and system commissioning are by others. This
Contractor must cooperate with MCMS to provide access and maintain the schedule for item
and occurrence for all testing and inspections. This Contractor must notify MCMS in writing at
least two (2) weeks in advance when testing and inspection are required. Contractor is
responsible for coordination of site inspections with both the applicable governmental
agencies and MCMS.

37. All materials, products and/or equipment furnished on this project shall be asbestos and PCB
free. Any subcontract this Contractor shall issue shall include the same phrase as above.

38. The omission from the drawings and/or specifications of any minor details of construction,
installation, material or essential specialties shall not relieve the Contractor from furnishing
the same, in place, complete and such omission shall not entitle the Contractor to make
claims for extras on material or labor after the award of contract.

39. This Contractor will “make safe” all hazardous, unsafe conditions caused by this Contractor.
40. No gasoline-powered equipment can be used at any time within buildings, use propane instead. All equipment you plan to use must be reviewed with the Superintendent for safety and noise concerns.

41. Where new construction occurs in fire-rated walls, floors, and/or roof, materials used shall be sufficient to maintain fire rating.

42. Contractor shall submit Daily Field Reports and Weekly Safety Meeting Minutes to MCMS Superintendent. These reports must indicate manpower by craft, quantities of work installed, detailed explanation of work performed or topic of discussion.

43. Contractor shall attend, as required, any meetings with Campus, Local, and State Authorities pertaining to their work. The Contractor shall perform all work in compliance with Local, State, and Federal building codes.

44. Contractor will coordinate all work with other trades and MCMS’s schedule. No claim for compensation by Contractor will be allowed for improper coordination.

45. Contractor includes any cutting and patching as required to perform their work. Include restoration of surfaces to original condition to include firestopping/firesafing if required.

46. This Contractor is responsible for all sleeves, inserts, anchors, and any additional reinforcements or supports for this work which is not detailed in the drawings.

47. Abide by all directions of the Fire Department in matters affecting life safety and fire prevention measures.

48. During this project, hot work permits will need to be obtained from MCMS prior to proceeding with any such work on a daily basis.

49. MCMS/Architect/Owner has the right, at no additional expense, to reject any material brought on site which does not conform to local, state, or national codes and/or which does not conform to the drawings and specifications. Any such material used on site shall be immediately removed and replaced at Contractor’s expense.

50. This Contractor shall coordinate and sequence his work with MCMS’s schedule, as outlined on Attachment 4 as well as reasonable short term scheduling needs. Time is of the essence, and therefore, the Contractor agrees to provide a sufficiency of workers to expedite the completion of all work made available to him. Furthermore, he shall work overtime as necessary, at no charge in cost, to make each scheduled completion date. (See section H2 for the schedule.)

51. Provide protection of new and existing work to prevent damage by own work.

52. This Contractor is responsible for all applicable use and excise taxes. This project is not tax exempt.

53. Obtain and pay for required applications, permits, and services necessary to complete the work associated with this contract.

54. Contractor shall not proceed with any work he deems as extra work, without written approval from MCMS. If Contractor proceeds without written approval, he does so at his own risk.

55. Your Contractors must be listed in the bid form. All Contractors must be state licensed and insured.
56. Building or site commissioning is to be performed separately from owner training.

57. All punch list work and project closeout documentation shall be completed and approved by the Owner and Architect by the "Date of Final Completion" which shall be no later than 14 days after the Date of Substantial Completion. Any uncompleted punch list items after this date will be completed by MCMS and back charged to the appropriate Contractor or vendor. Final invoices will not be processed until final completion of the work and certification of same by MCMS, the Owner, and Architect.

58. Any potential material or wage escalation costs for the life of the project. To the extent possible, Contractor will work with Construction Manager in an effort to try to identify onsite storage accommodations for pre-ordered materials. If onsite storage cannot be accommodated, Contractor will be responsible for storing materials off site.

59. The requirement to meet all required manufacturer and specified material requirements.

60. All necessary traffic control measures required for the safe prosecution of the Work.

61. Contractor shall provide all shoring and bracing as required to perform scope of work.

62. Place a “PA One Call” prior to starting any excavation. Prior to commencement of an excavation for the project duration a current One Call should be completed. “PA One Call” receipts should be forwarded to MCMS for record.

63. Contractor shall enter and exit the site via only designated entrances. These entrances will be subject to change depending on the status of construction.

64. Contractor is responsible for providing any office space required to manage their on-site operations. Space is very limited and space for office trailers or shanties on site will not be allowed unless approved by the Construction Manager. Construction Manager will also approve the size and duration that the trailer will be allowed on site.

65. Contractor shall provide required fire extinguishers at work stations, gang boxes, shanties, and storage areas and at work locations where flame producing procedures are used.

66. Each Contractor shall remove all snow and ice as may be required for the proper protection and timely execution of his Subcontract.

67. During the construction, the Contractor may install temporary building enclosures in openings to provide weather protection. Contractor is responsible to replace the enclosure if it is removed/damaged by their actions.

68. For the purposes of this Subcontract, the term “provide” shall mean “furnish and install complete.”

69. The Contractor has read and fully understands the requirements of the Disadvantage Business Enterprise (DBE) Program for the project.

70. Building Information Modeling (BIM) will be used on this project. The purpose of using BIM on the PSU Henderson Behavioral Health Building is to supplement the coordination process between trades and design disciplines. Contractors will be required to fully participate in the BIM process from the start of coordination drawings to the completion of the project and as-builds. (See Section H5)

71. Once complete, the building elevators are not to be used at any time during this project. All trades are to provide for their own hoisting.
72. Contractors are to submit all submittals and shop drawings in an electronic format through Prolog Converge, a web-based collaborative tool. Contractors will be provided user accounts. Each Contractor will be responsible for a $75.00/month fee payable to Massaro CM Services.

73. Contractors will use Prolog Converge to electronically submit all RFIs, Submittals and Daily Reports to the Construction Manager.

74. PROJECT CLEAN-UP REQUIREMENTS:

   A. This Contractor shall perform daily and final cleanup as directed by MCMS. Trash generated from Contractor daily operations will be sorted and will be put in to designated dumpsters for removal to recycling facility. Final cleanup shall be defined as removing all of this Contractor’s excess material debris generated by this Contractor’s work and their “gang” boxes at the end of a completed area of work and as directed by MCMS. No janitorial services shall be performed by the Construction Manager.

   B. Every firm, regardless of crew size, is to clean up their work area on a daily basis.

   C. In addition, one day a week the Construction Manager will coordinate and assemble a composite clean up crew consisting of one person from each Contractor (includes Subcontractors) with a crew size of more than 5 people on site. Contractors with crew sizes of 5-10 people will contribute 1 person to the clean-up crew. 11-20 people will need to contribute 2 people to the crew, 21-30 people – 3, etc.

   D. This composite clean-up crew is for general clean up on both the site and in the building and is supplemental to the daily clean up to be provided by each contractor of debris generated by their activities.

   E. The clean-up crew will be employed 8 hrs/day one day a week.

   F. The Construction Manager will provide the oversight and direction to the clean-up crew.

   G. Failure to provide the required person(s) will result in a backcharge of $100/hour per missing person.

75. COORDINATION DRAWINGS:

   A. Initiation and follow through of Coordinated Drawings shall be the responsibility of the mechanical contractor.

   B. Mechanical contractor shall develop a Coordinated Drawing Schedule. This schedule shall indicate each area and section and anticipated completion date.

   C. Construction Manager will hold weekly Coordination Meetings until the coordination effort is complete. Attendance is mandatory for all participants.

   D. Starting with the sheet metal, the drawings process will progress through HVAC piping and plumbing piping. The Mechanical contractor shall then provide copies to the electrical contractor, sprinkler contractor and contractors have support framing above the ceiling for their review and comment.

   E. The Duct Coordinated Drawings shall be utilized for the Sheet Metal and Duct Systems shop drawing and submitted for approval concurrently with coordination with other trades. Any changes or modification due to coordination shall be submitted for engineer review.

   F. Upon review by all parties and after all concerns are addressed, drawings (reproducibles) will be signed off.

   G. The mechanical contractor shall then make three (3) copies for each contractor, CM five (5) copies and Balancing Contractor two (2) copies. The mechanical contractor shall maintain the reproducibles and furnish to Construction Manager at the project completion. All field modifications shall be recorded on these drawings and utilized as
the Project Record Documents, along with cross references to the contract documents. Record Drawings shall not be used as construction drawings.

H. Any modifications to the signed off drawings will be submitted for record and signed off by all contractors.

I. Only signed off coordination drawings shall be used in the field.

J. Any contractor not adhering to this requirement shall be completely responsible for any conflicts or problems as a result.

K. All participants will establish piping elevation, main electrical feeder, light fixture, cable tray and sprinkler elevations and general locations before proceeding with coordinated drawings.

L. At the end of the project, the as built coordination drawings will be submitted both in drawing and electronic form (CADD or BIM if applicable.)

END OF SECTION
Preliminary Schedule

Time is of the essence for this work. Contractors must make all necessary provisions for labor and material delivery in order to accomplish the Substantial Completion of the new Henderson – Biobehavioral Health Building by October 30, 2012 with the start of construction in December 2010. The Abatement and Demolition Contracts will need to meet the completion dates indicated in Section A of these Bid Documents.

Within thirty (30) days after execution of the Contract each Prime Contractor shall have submitted to the Construction Manager and the General Trades Contractor a schedule outlining all phases of the work that clearly identifies sequence of work, manpower requirements, durations to complete each major work area, critical starting dates, long lead item approval/release, delivery dates and expected shift work. This schedule must be coordinated by the General Trades Contractor and with all other Prime Contractors so that at the time of submission each Prime Contractor will sign off on the schedule approving it for use in development of the overall project schedule by the General Trades Contractor. As work progresses, updated two week look-ahead schedules must be provided to coincide with the project meeting dates. In addition, a shop drawing submission schedule must be provided within ten working days showing all items requiring shop drawings and/or catalog cuts. This schedule must specify the estimated date of submission, fabrication times, the delivery dates require to maintain the Project Schedule and be tied to the master Project Schedule.

The attached “Milestone Schedule for Bidding” is a timeline and represents only the required substantial completion dates. All other activity dates will change based on development of the actual project schedule by the team of Prime Contractors who ultimately complete the bid package work for this project.
<table>
<thead>
<tr>
<th>Act ID</th>
<th>Description</th>
<th>Ord Dur</th>
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<th>Early Finish</th>
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<td>19MAY11 * 11AUG11</td>
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<td>Delivery of Penthouse Mechanical Equipment</td>
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<td>Roof Dried-In</td>
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</table>

Henderson - Biobehavioral Health Building
DGS 800-290/PSU 06-42744/BCJ 08001

Massaro CM Services, LLC
PSU Henderson Addition - Biobehavioral Health Building
Milestone Schedule for Bidding

DGS Project #800-290
PSU Project #06-42744
BCJ Project #08001

Finish date 14NOV12
Data date 02NOV10
Run date 13SEP10
Page number 1A

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Project Overview:

This study focuses on the phasing and site logistics required to facilitate the proposed new construction currently scheduled for the Henderson complex of buildings. This proposed new construction includes Henderson Addition – Biobehavioral Health Building which will be located between Henderson North and Henderson South, and the north rim of the HUB Lawn.

The Henderson complex of buildings is situated between Old Main (to the west) and the HUB Lawn (to the east). Due to its location on campus and close proximity of the surrounding facilities it will be necessary to utilize a large portion of the HUB Lawn for staging and lay-down during construction. Because of space limitations and the adjacency of the project, it was always the intent to keep and maintain a portion of the staging and lay-down space for the duration of the project.

Henderson Addition – Biobehavioral Health Building:

This project starts the construction sequence for the Henderson Complex. This project includes the replacement of the existing Henderson Bridge building with a new 94,000 square foot state of the art academic facility. Due to the building’s central location this project also includes utility work located north of the construction site. This utility work will impact both Henderson North and Henderson South.

Prior to the commencement of the construction phase, measures will be implemented that establish access to the site throughout the construction phase. Several considerations and studies were made in order to get the site logistics for this congested area correctly designed to insure a smooth flowing construction process for not only this project but the subsequent phase.

- Safety is a major consideration on all projects. The construction area will be isolated from the rest of the campus and students through the use of a 6'-0" high chain link fence with blue, windscreen mesh around the entire perimeter of the site. To further enhance safety an additional fence running north to south from the construction staging area to the construction entrance at College Avenue and west to the entrance gate will provide an extra protective barrier to insure no conflicts between pedestrians and construction traffic. This fence will provide access provisions for all construction equipment & personnel, and will provide a physical barrier between the danger area and the rest of the campus. This will stay in place for the entire construction duration.

- Vehicle access to Henderson North will be affected by the removal and replacement of a large portion of roadway. This road work is necessary in order to expose and then extend & install new chilled water lines that service the surrounding buildings. To maintain safe use and insure accessibility during construction, traffic maintenance including flagging personnel, barricades and signage will be utilized. It is anticipated that this work will occur during the first summer (2011) of the 22 month construction schedule in order to reduce impacts on student foot traffic and deliveries.

- A temporary walk running east to west across the HUB lawn will be installed during this project outside of the construction zone to the North of the staging lay down area. This will provide the students with a path across the HUB Lawn to access other portions of the campus safely without enduring a lengthy detour. This will remain in place for the duration of the project.

- A designated student egress pathway running north to south utilizing the north east exit of Henderson East will be installed to facilitate the safe passage of students from this building during the project. To isolate students from the construction and to insure safe passage, this pathway is segregated with 6'-0" high temporary construction fence which will remain in place
throughout the project. This pathway provides safe, unrestricted passage between the Henderson East Building and the lower parking lot that will remain in use.

- The construction staging and lay-down area inside the construction fence will be utilized for the placement of job trailers from the various contractors, stockpile any soil that will be utilized for the project, a lay-down or work area for contractors to stage from, and very limited vehicle parking. This area provides adequate access to all sides of the new building for equipment and material stocking.

- One area of special consideration is the utility tunnel that runs east to west at the south portion of the construction site. The tunnel is scheduled to receive a new cast in place structural support shell to minimize loading impacts to the existing tunnel structure and will include replacement of some portions of the existing vault that are deteriorating. To protect this component from further damage, stone base covered with steel plating will be installed for the duration of construction.

- The affected area of the HUB lawn will also be protected. As a protective measure during its use as a staging area, the portion of the HUB Lawn being used (as a staging/lay down area) will have a geo-textile fabric membrane placed over the lawn surface and 8” inches of stone will be used to cover the fabric to prevent over compaction of the lawn area underneath. This will stay in place and be maintained throughout construction. Once this protective system is no longer required, it will be removed and the lawn surface repaired. The same treatment will be provided for existing trees nearby trees including protective fencing.

- Access to the site was a major consideration due to the location of the project and the surrounding facilities. Thought was given to utilize any existing elements that could minimize the impact to the area, yet provide adequate access for construction vehicles and deliveries while maintaining access to the surrounding buildings. This was accomplished by using and augmenting the existing pedestrian / bike path coming up from College Avenue. This area was widened to enhance the turning radius for large vehicles turning off of College Avenue. In addition to widening the access road, several parking spots will be purchased to increase the safe swing radius for exiting construction traffic onto College Avenue. This will provide entry to the construction site. A similar concept was used to widen an existing spur towards Henderson South that will be utilized as both a construction exit. This radius of this spur is positioned to get construction traffic back onto College Avenue in a smooth transition, minimizing sharp angled turns.

- As an additional measure of traffic control, a gate will be placed on the entrance and exit from College Avenue. Full time flagging personnel will also be present to insure both smooth flow and integration of the construction traffic onto College Avenue, and the safety of pedestrians that traverse this area on a daily basis.

- A tire wash station will be utilized to minimize debris leaving the site onto College Avenue.

- The currently proposed scheme seems to be the best choice of location, use of the surrounding areas, and minimized impact to the site; however this plan will require the relocation of several trees and an existing light pole to facilitate its implementation.
Penn State University
University Park Campus
Henderson Addition - Bio-Behavioral Health Building
DGS Project Number 800-290
PSU Project Number 06-42744

Site Logistics
Current as of 09-09-2010

Contact
Dick Iddings
Pennsylvania State University
Building Service Coordinator
256 South Henderson
814.863.0890
rli1@psu.edu

Massaro
www.massarocorporation.com

ACCESS FOR HENDERSON NORTH VEHICULAR/DELIVERIES

MAINTAIN STUDENT TRAFFIC

HUB LAWN - NORTH PERFORMING AREA

TEMPORARY WALK FOR STUDENTS

AUTHORIZED DELIVERIES ONLY

TEMPORARY WALK FOR STUDENTS

MAINTAIN STUDENT TRAFFIC

STOCKPILE TOP SOIL

OFFICE TRAILERS

HENDERSON - BIO-BEHAVIORAL HEALTH BUILDING

DGS 800-290/PSU 06-42744/BCJ 08001

Site Logistics
Current as of 09-09-2010

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HENDERSON - BIO-BEHAVIORAL HEALTH BUILDING

DGS 800-290/PSU 06-42744/BCJ 08001

Setion H3
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THE PENNSYLVANIA STATE UNIVERSITY

HENDERSON ADDITION – BIOBEHAVIORAL HEALTH BUILDING

DGS Project Number 800-290
PSU Project Number 06-42744

GEOTECHNICAL REPORT
March 31, 2009
GEOTECHNICAL REPORT

Henderson Building Additions – Phase I
The Pennsylvania State University – University Park Campus
State College Borough, Centre County, Pennsylvania

CMT Laboratories File No. 09803

Prepared for:

The Pennsylvania State University
Office of Physical Plant
106 Physical Plant Building
University Park, PA 16802

Prepared by:

CMT Laboratories, Inc.
2701 Carolean Industrial Drive
State College, PA 16801

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GEOTECHNICAL REPORT

Henderson Building Additions – Phase I
The Pennsylvania State University – University Park Campus
State College Borough, Centre County, Pennsylvania
March 31, 2009

INTRODUCTION

This report presents the results of a subsurface exploration and foundation analysis for Phase I of the proposed Henderson Building additions, located on the University Park campus of The Pennsylvania State University in State College Borough, Centre County, Pennsylvania.

Our services for this project were performed in accordance with CMT Proposal No. D09010, dated January 14, 2009 and revised January 21, 2009. Authorization to perform this exploration and analysis was given in the form of Penn State Purchase Order Number 335804-E, authorized by Ms. Joyce A. Haney and dated February 2, 2009.

The purpose of the test boring program was to determine the pertinent subsurface conditions and to obtain information on which to base recommendations regarding foundation design and other geotechnical aspects. The scope of services does not include an environmental assessment for the presence or absence of wetlands, hazardous, radioactive or toxic materials in the soil, surface water, groundwater, or air on, below or around the site. Any statements in this report or on the Test Boring Logs regarding odors, colors or unusual or suspicious items are strictly for the information of the client.

PROJECT AND SITE INFORMATION

The proposed Henderson Building additions are located at the existing Henderson North and South buildings on the University Park campus of The Pennsylvania State University in State College Borough, Centre County, Pennsylvania. The precise location of the proposed project is shown on a Boring Location Plan prepared by Robert Silman Associates and dated December 12, 2008.
The surface of the site, within the proposed construction footprint, contains areas that are grass covered, areas that are landscaped and areas that are covered with asphalt concrete. At the southwestern portion of the proposed building, there is an Office Link which connects Henderson South Building and Henderson North Building.

Topographic information was taken from a site plan prepared by Sweetland Engineering & Associates, Inc. In general, the site slopes gradually downward from west to east. Specifically, ground surface elevations range between approximately 1148 feet, at the southwestern end of the proposed building, to approximately 1141 feet, at the eastern corner of the proposed building.

General project information was provided by Mr. Allen H. Kachel, AIA LEED AP with Bohlin Cywinski Jackson, as well as taken from the project’s “General Requirements for Subsurface Exploration and Analysis,” prepared by Robert Silman Associates. According to this information, the proposed redevelopment of the Henderson Complex will be completed in two (2) phases. Phase I involves the complete demolition of the Office Link and replacement with a new 78,500 GSF structure, which will include one (1) below grade level and four (4) floors above grade. The basement floor elevation will be approximately 1132 feet, and the northeastern portion of the proposed building will contain an auditorium with an approximate floor elevation of 1127 feet. Specific structural information was not available at the time of this report; however, the structural system will likely consist of either concrete or steel.

Structural loading information was provided by Mr. Dipa Makim, P.E. with Robert Silman Associates. According to this information, column loads will range between 400 and 800 kips and wall loads will range between 5 and 8 kips per lineal foot. For the purpose of our analysis, we have assumed maximum floor loads of 250 pounds per square foot. In addition, we have assumed maximum tolerable total and differential settlement values of 1 inch and ½ of an inch, respectively.

The above information was utilized in our geotechnical analysis. Therefore, if any of this information has changed, is incorrect or becomes available in the future, please inform CMT so that we may amend the recommendations presented in this report, if appropriate.
GENERAL

The following recommendations are based on general subsurface information shown on the Test Boring Logs located in Appendix C. The descriptions shown on the Test Boring Logs represent the conditions only at the actual test boring locations. Variations may occur and should be expected between the test boring locations. Conditions encountered during excavation procedures may not reflect the conditions presented on the Test Boring Logs. Therefore, a representative of CMT should be present during excavation operations so that any variations may be presented to the geotechnical engineer. The geotechnical engineer may decide that the variations warrant a change to the recommendations presented in this report.

GEOLOGIC INFORMATION

According to the Department of Environmental Resources, Office of Resources Management, Bureau of Topographic and Geologic Survey (1982), bedrock formations at the proposed site are classified as the Nittany Formation (On). The bedrock within this formation is comprised of light to dark gray, finely to coarsely crystalline dolomite with alternating beds of sandy, cherty dolomite. The bedrock is moderately resistant to weathering to a shallow depth and small to medium sized flat, rectangular fragments result from weathering. The interface between the bedrock and the soil mantle is characterized by pinnacles and the development of joint channels is common. Excavation of the bedrock is difficult and cut-slope stability is good in most areas. Foundation stability is good, provided that the bedrock has been thoroughly investigated for solution openings.
FIELD INVESTIGATION

CMT notified the Pennsylvania One Call System, Inc. prior to the commencement of our field operations and Serial Number 20090570237 was assigned to this phase of the project. In addition, all field operations were coordinated with Penn State personnel. The Contractor should verify the precise location of any utilities prior to commencement of construction activities.

The field investigation consisted of six (6) test borings, at locations specified by Robert Silman Associates. Note that three (3) of the test borings were relocated slightly due to utility conflicts and site constraints. The test borings were extended to depths ranging between 21.5 and 44.0 feet below the existing surface grades and were located in the field by a representative of CMT referencing the site plan and utilizing standard location procedures. A Professional Land Surveyor was not employed for this purpose. The ground surface elevations shown on the Test Boring Logs were estimated from site plan contours. The approximate locations of the test borings are shown on the Test Boring Location Plan located in Appendix A.

The soil sampling was performed in accordance with ASTM D1586. All sampling intervals and Standard Penetration Test values were recorded and are shown on the Test Boring Logs included in Appendix C. The results of the Standard Penetration Tests indicate the relative density and comparative consistency of the soils and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

Where auger refusal was encountered, at all test boring locations, the underlying material was cored with NQ-II wireline equipment. Auger refusal is the designation given to any material which cannot be further penetrated by the power auger and is usually indicative of boulders, lenses or the upper surface of bedrock. The recovery and RQD (Rock Quality Designation) percentages are shown on the Test Boring Logs. Analysis and interpretation of the recovery and RQD percentages provides a general description of the overall rock quality.
The stratifications shown on the Test Boring Logs represent the conditions only at the actual test boring locations. Variations should be expected throughout the site. In addition, the Test Boring Logs show the approximate boundaries between subsurface materials. Actual transitions between subsurface materials may be gradual.

**Groundwater Conditions**

A groundwater table was not encountered in the test borings at the time of field activities. Note that groundwater levels fluctuate seasonally as a function of precipitation and the permeability of the subsurface materials. There is the possibility that groundwater will have an effect on the excavation procedures during construction. We recommend that the actual groundwater conditions be determined at the time of construction.

**LABORATORY TESTING PROGRAM**

The samples obtained during the drilling operations were sealed in labeled containers and transported to our laboratory for inspection, testing and classification. Remaining samples will be retained for a minimum of one (1) year for future reference.

In addition to visual classification of the soil samples, moisture content determination tests were performed on representative split-spoon samples. The moisture content is the ratio of the weight of the water in the sample to the dry weight of the sample. These tests were performed in general compliance with ASTM D2216.

Hand penetrometer values were obtained on representative natural cohesive split-spoon samples. These values provide a basis for estimating the relative strength and compressibility of the soil.

Moisture-plasticity characteristics of two (2) soil samples were determined by means of the Atterberg Limit tests. The test determines the moisture content at which the soil begins to act as a viscous liquid (Liquid Limit - LL) and the moisture content at which the soil changes from a plastic state to a semi-solid state (Plastic Limit - PL). The
difference between the Liquid Limit and the Plastic Limit is the Plasticity Index - PI. The
test procedures were performed in compliance with ASTM D4318.

Particle-size analyses were performed on the same soil samples in compliance
with ASTM D422. The procedure includes a sieve analysis for particle sizes greater than
the #200 sieve and a hydrometer analysis for particle sizes smaller than the #200 sieve.
Using this information, the samples were classified using the Unified Soil Classification
System (USCS), ASTM D2487.

The following is a summary of the soil classification results:

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<th>Location of Sample</th>
<th>CMT Sample Number</th>
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<th>Plasticity Index (PI)</th>
<th>USCS Classification</th>
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<td>9155</td>
<td>41</td>
<td>21</td>
<td>CL</td>
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<tr>
<td>TB-1, 10.0-15.0’</td>
<td>9157</td>
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Unconfined compression tests were performed on three (3) intact rock core
specimens. These tests were performed in general compliance with ASTM D7012-04,
Method C, and a summary of these tests is provided in the following table:

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<td>39,450</td>
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</table>

A more detailed analysis of all laboratory testing results is presented in Appendix
D of this report.
SUBSURFACE CONDITIONS

Details of the subsurface conditions encountered in our field exploration are shown on the Test Boring Logs, included in Appendix C. A brief description of the materials encountered is presented in this section.

The surface of the site, at test boring locations TB-1, TB-3 and TB-6, consists of a layer of topsoil measuring between 6 and 8 inches in thickness. The topsoil contains organic matter due to the decay of vegetation and natural weathering processes and should be considered highly compressible. Due to the fact that the locations of the test borings were not intended to quantify the topsoil on the site, the topsoil depths shown on the Test Boring Logs should not be deemed adequate for cut/fill calculations.

The surface of the site, at test boring locations TB-2, TB-4 and TB-5, consists of a layer of asphalt concrete measuring approximately 8 inches in thickness. A discernable layer of gravel subbase was not encountered beneath the asphalt concrete.

The topsoil or asphalt concrete, at test boring locations TB-1, TB-2, TB-4 and TB-5, is underlain by fill materials, which consist predominantly of clay and weathered dolomite fragments with varying amounts of silt and sand. The fill material extends to depths ranging between 1.5 and 5 feet below the existing surface grades and has moisture contents ranging between 4 and 18 percent. The engineering characteristics of the fill material, such as strength and compressibility, are likely to be variable.

The above described materials, at all test boring locations, are underlain by natural residual cohesive soils. The natural residual cohesive soils consist predominantly of clay and silt sized particles with varying amounts of sand, gravel and weathered dolomite and extend to depths ranging between 8 and 15 feet below the existing surface grades. These soils have moisture contents ranging between 11 and 37 percent and exhibit a soft to stiff relative density, based upon the results of the Standard Penetration Tests and hand penetrometer values. CMT Sample Numbers 9155 and 9157 are representative of the natural residual soils.

At all test boring locations, the natural residual cohesive soils are underlain by dolomite bedrock, which was cored upon encountering auger refusal at depths ranging
between 4.5 and 21.5 feet below the existing surface grades. In general, the dolomite bedrock was in a broken to massive, slightly weathered to highly weathered and hard condition. Clay seams were present within portions of the bedrock. Rock core recovery values within the bedrock ranged between 4 and 100 percent and Rock Quality Designation (RQD) values within the bedrock ranged between 0 and 94 percent. Refer to the Test Boring Logs for further data regarding the rock core recovery and RQD percentages.

RECOMMENDATIONS

The conclusions and recommendations presented in this report are based on the data obtained from the field exploration and laboratory testing programs, information regarding the proposed construction and our knowledge of geomechanics. The subject site is considered suitable for the proposed construction, provided the geotechnical recommendations and suggested construction guidelines presented in this report are utilized in both the design and construction phases of this project.

Specific and detailed recommendations are provided in the following sections.

Sinkhole Potential

Although our test borings, which were extended into the underlying carbonate bedrock, did not reveal an active collapse or failure of the overlying materials into an existing cavity within the bedrock, the potential for sinkhole formation exists as it does for the surrounding properties. The risk for sinkhole formation is greatest during construction, when the bedrock and soil are exposed to atmospheric conditions. Every effort should be taken to prevent infiltration of runoff and precipitation into the underlying natural soils and bedrock in the vicinity of the proposed construction.
Rock Removal Considerations

Based upon the material encountered during the subsurface exploration, removal of dolomite bedrock will be required. Specifically, rock removal depths will be on the order of 8 feet for the proposed auditorium. Due the pinnacled nature of the site’s geologic formation, bedrock may be encountered at elevations higher than shown on the Test Boring Logs.

Removal of the bedrock may require special excavation techniques, such as air rotary drilling or pneumatic jack hammering, in order to facilitate removal. The method required for rock removal will depend on the weathered and intact nature of the bedrock. It is the responsibility of the contractor to determine the rock removal method, provided that method is acceptable to the owner and in compliance with any applicable ordinances and regulations.

Site Preparation

Site preparation should include the removal of all topsoil, organic matter, or any soft/wet/frozen soils, which may be highly compressible. In addition, the Office Link and all asphalt concrete should be removed. Any excavations associated with the removal of structures or subsurface utility lines should be evaluated by the geotechnical engineer or designated representative prior to backfilling.

After achieving finished subgrade in cut areas and prior to placing structural fill in areas below finished subgrade, the exposed subgrade should be evaluated to confirm that all unsuitable or unstable materials have been removed. Where practical, those areas that are at finished subgrade or those areas that are to receive structural fill should be proofrolled with an appropriately loaded, tandem-axle dump truck or similar pneumatic-tired equipment. Proofrolling will help to reveal the presence of unstable materials that were not identified during our test boring program. A representative of CMT should observe all proofrolling activities. Soft or unstable soils should be removed prior to construction activities.
If proofrolling is not feasible, the subgrade should be visually inspected and manually probed by the geotechnical engineer or designated representative. Soft or unstable soils should be removed prior to construction activities.

**Structural Fill Placement**

Structural fill is defined as all fill placed under and around foundations, floor slabs, utilities, sidewalks and pavements. Suitability of backfill material should be evaluated during construction based upon its intended use.

The on-site fill material and natural soils should not be reused as structural fill for this project. These soils can be used in areas to be landscaped.

In general, structural fill should satisfy the following criteria: Any material utilized as structural fill should not contain rock greater than 3 inches in diameter and should not contain more than 1 percent (by weight) of organic material or other deleterious material. The material should fall under one of the following Unified Soil Classifications: GW, GM, GC, SW, SM, SC, some CL (Liquid Limit less than 40) and combinations thereof. PennDOT 2B and AASHTO No. 57 stone are not considered suitable structural fill materials. Potentially expansive materials such as mine tailings, pyritic shale and slag should not be used as structural fill material. Additionally, frozen soils should not be utilized as structural fill. Other materials should be considered on a case-by-case basis. Alternate materials should be approved by the geotechnical engineer.

Poorly or uniformly graded structural fill, or structural fill exhibiting little or no cohesion may be difficult to compact in areas lacking lateral confinement. Without confinement, and when subjected to compactive effort, these soils will have a tendency to displace horizontally rather than compact.

All structural fill should be placed in horizontal lifts not exceeding 8 inches in loose thickness and within 2 percent of optimum moisture for compaction. The fill should be compacted to 100 percent of maximum dry density as determined by the Standard Proctor method (ASTM D698). Fill materials placed in non-structural or
landscaped areas should be compacted to a minimum of 95 percent of the maximum dry density.

The placement and compaction of fill should be monitored by a soils technician, working under the direction of a geotechnical engineer, to confirm that the specified degree of compaction is being obtained. The frequency of testing should be related to work conditions during earthmoving and the type and location of the fill or backfill.

**Groundwater Control**

Due to the absence of groundwater during our field exploration, it is unlikely that groundwater will be encountered during excavation operations; however, wet soil conditions may be encountered near the soil/bedrock interface. If groundwater is encountered, every effort should be made to keep the excavations dry. An open pump, gravity drainage system or other conventional dewatering procedure may be sufficient for these temporary purposes.

**Drainage**

Proper site drainage should be maintained throughout earthwork operations to minimize wet weather delays, to reduce the accumulation of moisture and to reduce the risk for sinkhole related subsidence. If the surficial soils become loosened during wet weather or frozen, these soils may need to be scarified and recompacted or removed before additional fill is placed. Also, the ground surface in the vicinity of the site should be graded so that surface water flows away from the construction.

Precautions should be taken relative to drainage in the design and construction phases. Final design plans should include measures to reduce water infiltration into the soils in order to decrease excessive erosion or soil piping into voids in the underlying carbonate bedrock, which could lead to subsurface instabilities. These measures would include providing watertight storm drains and drains that tie directly into storm drainage systems.
Foundation Recommendations

Based on the subsurface conditions encountered during our field exploration, we recommend conventional shallow foundations, consisting of continuous wall and spread/column footings, bearing on dolomite bedrock for this project. In areas where material other than dolomite bedrock is encountered at the bearing elevation, we recommend that the footings be overexcavated to dolomite bedrock and backfilled with lean concrete. Based upon the test boring data, some overexcavation will be required to remove clay and a clay/rock mixture.

Conventional continuous wall and spread/column footings bearing on dolomite bedrock and/or lean concrete can be sized for a maximum net allowable bearing capacity of 15,000 pounds per square foot. This allowable bearing pressure should include dead load plus sustained live loads. In order to provide for proper workspace, we recommend minimum footing widths of 2 and 3 feet for conventional continuous wall footings and spread/column footings, respectively. Foundation excavation and construction should be monitored continuously by a representative of CMT.

The footings should bear on sound bedrock, free of clay seams or voids at or near the bearing elevation. In addition, the bearing material should be as uniform as possible to reduce the potential for stress concentrations to occur on the footings. To ensure a uniform bearing surface, as well as to facilitate proper inspection and evaluation, all loose rock and other material must be removed from the foundation excavations. Once exposed, a representative of CMT should evaluate the bearing material to ensure that it is capable of providing the 15,000 pounds per square foot bearing capacity. Unstable areas, if encountered, will require overexcavation to sound bedrock. Any overexcavations beneath foundations should then be backfilled with lean concrete.

The rock bearing surfaces should be nearly horizontal to preclude sliding of the footings along the footing-rock interface. If foundation excavation results in sloped bearing surfaces on the order of or greater than 20 degrees from the horizontal, the geotechnical engineer should be consulted on how to proceed with the construction. Depending on the conditions encountered, possible remedies could include placing a
leveling course of lean concrete and/or providing lateral stability by embedding dowels into the bedrock.

Assuming the net loading on the footings does not exceed 15,000 pounds per square foot and the recommendations in this report are followed, total post-construction and differential settlement should both be less than the assumed tolerable values.

For protection against frost damage, all exterior foundations should be constructed at least 42 inches below final exterior grade. Concrete should be placed in the foundation as soon as practical after excavation to minimize the possibility of water and/or debris entering and collecting within the open excavations. Foundations should be suitably reinforced as per structural considerations.

**Adjacent Structure Considerations**

Special care should be taken to prevent disturbance of the bearing materials under and adjacent to the foundations of the existing buildings during foundation construction and earthwork activities. Special precautionary measures, such as underpinning, may become necessary if this is not possible. CMT should be given the opportunity to review and comment on any underpinning designs.

Also, note that vibration from construction equipment in close proximity to the existing structures may induce structural distress. We recommend that the adjacent structures be closely monitored during construction, particularly during rock removal operations.

**Slope Stability and Bracing/Shoring Considerations**

Due to the below grade depth of the proposed construction, either benching/sloping or temporary bracing/shoring will be required.

A minimum of a 1H:1V slope should be utilized for temporary (less than 24 hours) excavations; however, all slopes should be inspected for stability. Dependent
upon the composition and stability of the subsurface material encountered, benching or sloping beyond a 1H:1V slope may be required.

If benching/sloping is not feasible, temporary bracing/shoring will be required. Subsurface drainage must be considered in the design and construction of temporary bracing/shoring systems. The following table presents parameters that can be utilized in the design of temporary bracing/shoring systems:

<table>
<thead>
<tr>
<th>Material</th>
<th>( \gamma_{\text{moist}} ) (pcf)</th>
<th>( \phi ) (degrees)</th>
<th>( c ) (psf)</th>
<th>( K_a )</th>
<th>( K_p )</th>
<th>( K_o )</th>
<th>( \varepsilon_{50} )</th>
<th>( k ) (pci)</th>
<th>( \sigma ) (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>115</td>
<td>10</td>
<td>1500</td>
<td>0.70</td>
<td>1.42</td>
<td>0.83</td>
<td>0.020</td>
<td>500</td>
<td>N/A</td>
</tr>
<tr>
<td>Silt</td>
<td>110</td>
<td>22</td>
<td>250</td>
<td>0.46</td>
<td>2.20</td>
<td>0.63</td>
<td>0.010</td>
<td>100</td>
<td>N/A</td>
</tr>
<tr>
<td>Dolomite</td>
<td>145</td>
<td>30</td>
<td>2000</td>
<td>0.33</td>
<td>3.00</td>
<td>0.50</td>
<td>N/A</td>
<td>N/A</td>
<td>12,000</td>
</tr>
</tbody>
</table>

Legend:  
\( \gamma_{\text{moist}} \) = Moist Unit Weight  
\( \phi \) = Undrained Angle of Internal Friction  
\( c \) = Cohesion  
\( K_a \) = Active Earth Pressure Coefficient  
\( K_p \) = Passive Earth Pressure Coefficient  
\( K_o \) = At-Rest Earth Pressure Coefficient  
\( \varepsilon_{50} \) = Strain Factor (Strain at 50% Stress)  
\( k \) = Soil-Modulus Parameter  
\( \sigma \) = Uniaxial Compressive Strength

**Lateral Earth Pressure Considerations**

We understand that the proposed construction will contain below grade walls, which will be required to resist at-rest lateral earth pressures imposed by the backfill materials.

We recommend the use of a cohesionless material, such as PennDOT 2A stone, to backfill the below grade walls. In order to prevent excessive lateral pressures during placement, the backfill should be placed in maximum vertical lifts measuring 4 inches in
loose thickness and compacted utilizing light compaction equipment. Also, in order to facilitate a proper work space, the excavations should be a minimum of 3 feet in width and at a stable slope (see “Excavations” section) from the base of the below grade walls. In areas not containing impervious pavements or sidewalks, the backfill should be capped with a 12 inch thick layer of compacted cohesive soils and sloped away from the walls. The on-site natural clay soils are considered suitable for this purpose. A Typical Below Grade Wall Backfilling Detail is presented in Appendix E.

The following parameters can be utilized in the design of below grade walls:

- Moist Unit Weight of PennDOT 2A Backfill Material ($\gamma_{2A}$): 135 lb/ft$^3$
- Angle of Internal Friction of PennDOT 2A (\(\phi\)): 38°
- At-Rest Earth Pressure Coefficient of PennDOT 2A Stone ($K_o$): 0.38
- At-Rest Earth Pressure Equation ($\sigma_o$): $\sigma_o = K_o(\gamma_{2A}H) + q K_o$ (psf)
  $H =$ height of backfill (ft)
  $q =$ surcharge pressure (psf)

**Grade Slabs**

The subgrade should be prepared according to the “Site Preparation” and “Structural Fill Placement” sections of this report. A modulus of subgrade reaction of 150 pounds per square inch/inch (psi/inch) can be utilized in the design of grade slabs. To reduce stress concentrations on the grade slab and to provide a uniform bearing surface, we recommend that a minimum of 6 inches of compacted PennDOT 2A stone be placed between grade slabs and the underlying subgrade. The stone will also act as a drainage course for any moisture below the slab.

**Seismic Considerations**

According to the 2006 International Building Code, Section 1613, Seismic Site Class C can be utilized in the design of the proposed structure.
EXCAVATIONS

The contractor is responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor is responsible for following the guidelines presented in the current version of the United States Department of Labor, Occupational Safety and Health Administration (OSHA), Part 1926, Subpart P, titled “Excavations.” This information is presented solely for the information of the client, and in no way is CMT Laboratories, Inc. responsible for the construction site safety or the Contractor’s activities.

COMMENTS

This report has been prepared to assist in the design of foundations and to aid in the general site preparation for Phase I of the proposed Henderson Building Additions, located on the University Park campus of The Pennsylvania State University in State College Borough, Centre County, Pennsylvania. The recommendations presented in this report are based on the subsurface information obtained by CMT and the general project information provided by others. The importance of inspection, consultation and testing during construction cannot be overemphasized.
We request that this office be consulted if, during design or construction, conditions are encountered which differ from those contained herein, thereby warranting a review of our recommendations. This report has been prepared for the exclusive use of The Pennsylvania State University.

Respectfully Submitted,

CMT LABORATORIES, INC.

[Signature]

Paul R. Thomas, E.I.T.

[Signature]

Shad E. Hoover, P.E.
APPENDIX A

TEST BORING LOCATION PLAN
APPENDIX B

GENERAL GEOTECHNICAL NOTES
General Geotechnical Notes

SOIL DESCRIPTION

The Unified Soil Classification System is used to identify the soil unless otherwise noted.

SAMPLE TYPES

| SS  | Split Spoon - 1 3/8" I.D., 2" O.D., unless otherwise noted. |
| ST  | Shelby Tube - 3" O.D., unless otherwise noted.               |
| GS  | Grab Sample (Bulk sample from auger cuttings).              |
| NQ  | Rock Core Sampled with Q Wireline Diamond Bit - 2" I.D.     |

SOIL PROPERTY SYMBOLS

- $q_p$: Pocket Penetrometer measurement of unconfined compressive strength - tsf
- $M_s$: Soil Moisture Content - %.
- GR: Graphical Representation of the soil strata (see below).
- LL: Liquid Limit - %.
- PI: Plasticity Index - %.
- Rec: Percent Core Recovery - Ratio of the length of rock core obtained, to the core interval.
- RQD: Rock Quality Designation - Ratio of the sum of core segments greater than 4", to the core interval.
- Groundwater Level at time noted after boring completion.

CONSISTENCY AND RELATIVE DENSITY CLASSIFICATION

<table>
<thead>
<tr>
<th>Cohesive Soils</th>
<th>$q_p$ - (tsf)</th>
<th>Granular Soils</th>
<th>SPT &quot;N&quot; Value</th>
<th>Descriptive Term</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Soft</td>
<td>0.00-0.25</td>
<td>Very Loose</td>
<td>0 - 4</td>
<td>Trace</td>
<td>1 - 10</td>
</tr>
<tr>
<td>Soft</td>
<td>0.25-0.50</td>
<td>Loose</td>
<td>5 - 10</td>
<td>Little</td>
<td>11 - 20</td>
</tr>
<tr>
<td>Firm (Medium)</td>
<td>0.50-1.00</td>
<td>Slightly Compact</td>
<td>11 - 20</td>
<td>Some</td>
<td>21 - 35</td>
</tr>
<tr>
<td>Stiff</td>
<td>1.00-2.00</td>
<td>Medium Dense</td>
<td>21 - 30</td>
<td>And</td>
<td>36 - 50</td>
</tr>
<tr>
<td>Very Stiff</td>
<td>2.00-4.00</td>
<td>Dense</td>
<td>31 - 50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hard</td>
<td>4.00+</td>
<td>Very Dense</td>
<td>50+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SOIL/ROCK STRATA LEGEND

- Clays
- Silts
- Sands & Gravels
- Organic Materials
- Fill Materials
- Limestone/Dolomite
- Shale
- Sandstone
- Siltstone
- Coal/Bitumen

ROCK QUALITY DESCRIPTION

<table>
<thead>
<tr>
<th>RQD</th>
<th>Rock Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 25%</td>
<td>Very Poor</td>
</tr>
<tr>
<td>25 - 50%</td>
<td>Poor</td>
</tr>
<tr>
<td>50 - 75%</td>
<td>Fair</td>
</tr>
<tr>
<td>75 - 90%</td>
<td>Good</td>
</tr>
<tr>
<td>90 - 100%</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

PARTICLE SIZE

<table>
<thead>
<tr>
<th>Material</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulders</td>
<td>12 in +</td>
</tr>
<tr>
<td>Cobbles</td>
<td>12 in - 3 in</td>
</tr>
<tr>
<td>Gravel</td>
<td>3 in - 5 mm</td>
</tr>
<tr>
<td>Coarse Sand</td>
<td>5 mm - 0.6 mm</td>
</tr>
<tr>
<td>Medium Sand</td>
<td>0.6 mm - 0.2 mm</td>
</tr>
<tr>
<td>Fine Sand</td>
<td>0.2 mm - 0.074 mm</td>
</tr>
<tr>
<td>Silt</td>
<td>0.074 mm - 0.002 mm</td>
</tr>
<tr>
<td>Clay</td>
<td>0.002 mm -</td>
</tr>
</tbody>
</table>

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APPENDIX C

TEST BORING LOGS
# Test Boring Log

**Boring:** TB-1  
**Date of Work:** 3/12/2009  
**File No.:** 090303  
**Core Bit:** NQ-II  
**Elevation:** 1147' +/-

<table>
<thead>
<tr>
<th>Description</th>
<th>Depth (ft)</th>
<th>Sample Type</th>
<th>Blow Counts</th>
<th>&quot;N&quot; Value</th>
<th>$d_v$ (tsf)</th>
<th>$M_e$ (%)</th>
<th>GR</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>8&quot; TOPSOIL</td>
<td></td>
<td>SS-1</td>
<td>2-4-3</td>
<td>7</td>
<td>---</td>
<td>17.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FILL MATERIAL - Dark brown clay,</td>
<td></td>
<td>SS-2</td>
<td>4-4-4</td>
<td>8</td>
<td>2.3</td>
<td>20.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>little silt, little sand, damp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown CLAY, little silt, little sand, little</td>
<td></td>
<td>SS-3</td>
<td>2-4-4</td>
<td>8</td>
<td>1.8</td>
<td>22.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>gravel, firm, damp</td>
<td></td>
<td>SS-4</td>
<td>6-6-8</td>
<td>14</td>
<td>1.2</td>
<td>29.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown silty CLAY, firm to stiff, moist</td>
<td>10</td>
<td>SS-5</td>
<td>4-4-4</td>
<td>8</td>
<td>0.9</td>
<td>36.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown clayey SILT, soft to firm, moist</td>
<td></td>
<td>SS-6</td>
<td>4-2-2</td>
<td>4</td>
<td>0.6</td>
<td>26.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown CLAY and gray weathered</td>
<td>15</td>
<td>SS-7</td>
<td>2-50/0.1</td>
<td>50/0.1</td>
<td>No Recovery</td>
<td></td>
<td></td>
<td>Auger Refusal - 21.5'</td>
</tr>
<tr>
<td>DOLOMITE, very dense</td>
<td></td>
<td>SS-8</td>
<td>50/0.1</td>
<td>---</td>
<td>No Recovery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gray weathered DOLOMITE, very dense</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Auger Refusal - 21.5'</td>
</tr>
<tr>
<td>Gray DOLOMITE, broken to massive,</td>
<td></td>
<td>NQ-1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Recovery = 84 RQD = 58</td>
</tr>
<tr>
<td>slightly weathered, hard</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Recovery = 80 RQD = 58 (See Note)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NQ-2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No Groundwater Table Encountered</td>
</tr>
<tr>
<td>End of Boring - 31.5'</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Note: The bottom 1.0' of sample NQ-2 could not</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>be retrieved. Actual recovery and RQD percentages</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>for this sample are likely to be higher than</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the indicated values.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Henderson - Biobehavioral Health Building  
DGS 800-290/PSU 06-42744/BCJ 08001  
Section H4  
12 November 2010  
Page 27 of 42
**Test Boring Log**

**Boring:** TB-2  
**Date of Work:** 3/9/2009

**Project Name:** Henderson Building Additions - Phase I  
**Site:** State College Borough, Centre County, Pennsylvania  
**Driller/helper:** R. Rager/M. Rager  
**Drill Rig:** Solimax (Truck)  
**Core Bit:** NQ-II  
**Auger Type:** 3-1/4" HSA  
**Sampling Type:** ASTM D-1586  
**Elevation:** 1144' +/-

<table>
<thead>
<tr>
<th>Description</th>
<th>Depth (ft)</th>
<th>Sample Type</th>
<th>Blow Counts</th>
<th>&quot;N&quot; Value</th>
<th>d_s (tsf)</th>
<th>M_s (%)</th>
<th>GR</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>8&quot; ASPHALT CONCRETE</td>
<td>5</td>
<td>SS-1</td>
<td>6-6-8</td>
<td>14</td>
<td>3.0</td>
<td>15.4</td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td>SS-2</td>
<td>7-6-7</td>
<td>13</td>
<td>4.2</td>
<td>15.4</td>
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<td>Brown sandy CLAY, some gravel, little silt, stiff, damp</td>
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<td>SS-3</td>
<td>6-7-50/0.2</td>
<td>57/0.7</td>
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<td>21.5</td>
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<td>Auger Refusal - 11.2'</td>
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<td>Gray DOLOMITE, little clay seams, broken to massive, weathered to slightly weathered, hard</td>
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# Test Boring Log

**Boring:** TB-3  
**Project Name:** Henderson Building Additions - Phase I  
**Date of Work:** 3/11/2009  
**Site:** State College Borough, Centre County, Pennsylvania  
**Driller/helper:** R. Rager/M. Rager  
**Drill Rig:** Mobile B-40 (ATV)  
**Auger Type:** 4" SSA  
**Sampling Type:** ASTM D-1586  
**Core Bit:** NQ-II  
**Elevation:** 1143' +/-

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<th>q_p (tfsf)</th>
<th>M_s (%)</th>
<th>GR</th>
<th>Remarks</th>
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<td>6&quot; TOPSOIL</td>
<td>SS-1</td>
<td>3-4-5</td>
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<td>23.1</td>
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<td>Brown silty CLAY, trace sand, trace gravel, firm to stiff, damp</td>
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<td>8-5-7</td>
<td>12</td>
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<td>22.8</td>
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<td>Auger refusal - 8.7'</td>
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<tr>
<td>Gray DOLOMITE, massive, slightly weathered, hard</td>
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<td>Recovery = 95</td>
<td>RQD = 77</td>
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<td>NQ-2</td>
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<td>Recovery = 62</td>
<td>RQD = 28</td>
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<tr>
<td>Gray DOLOMITE, slightly broken to massive, slightly weathered, hard</td>
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<td>Recovery = 100</td>
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# Test Boring Log

**Boring:** TB-4

**Project Name:** Henderson Building Additions - Phase I

**Date of Work:** 3/9/2009

**Site:** State College Borough, Centre County, Pennsylvania

**File No.:** 09803

**Driller/helper:** R. Rager/M. Rager

**Drill Rig:** Soilmix (Truck)

**Auger Type:** 3-1/4" HSA

**Sampling Type:** ASTM D-1586

**Core Bit:** NQ-II

**Elevation:** 1142' +/-

## Description

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<th>M&lt;sub&gt;n&lt;/sub&gt; (%)</th>
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<td>23.1</td>
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<td>Auger Refusal - 9.5'</td>
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<tr>
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<td>10</td>
<td>NQ-1</td>
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<td>Recovery = 46</td>
<td>RQD = 16</td>
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<td>Recovery = 94</td>
<td>RQD = 62</td>
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## Test Boring Log

**Boring:** TB-5 (1 of 2)

**Project Name:** Henderson Building Additions - Phase I  
**Site:** State College Borough, Centre County, Pennsylvania

**Driller/helper:** R. Rager/M. Rager  
**Drill Rig:** Soilmex (Truck)  
**Auger Type:** 3-1/4" HSA  
**Sampling Type:** ASTM D-1586  
**Date of Work:** 3/10/2009  
**File No.:** 06803  
**Core Bit:** NQ-II  
**Elevation:** 1142' +/-

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<th>qd (tsf)</th>
<th>Mw (%)</th>
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<th>Remarks</th>
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<td>Brown CLAY, little silt, little sand, little gravel, stiff, damp to moist</td>
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<td>6-6-7</td>
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<td>Auger Refusal - 9.0'</td>
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<tr>
<td>Gray DOLOMITE and brown CLAY, broken, weathered, hard</td>
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<td>Recovery = 30</td>
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<td>Gray DOLOMITE, some highly weathered zones, broken to slightly broken, highly weathered to slightly weathered, hard</td>
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<td>Recovery = 84</td>
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<td>Recovery = 100</td>
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<td>NQ-4</td>
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<td>Recovery = 78</td>
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<td>Recovery = 100</td>
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Continued on next page

CMT Laboratories, Inc.  
2701 Carolean Industrial Drive  
State College, PA 16801  
Phone: (814) 231-8845

Henderson - Biobehavioral Health Building  
DGS 800-290/PSU 06-42744/BCJ 08001  
12 November 2010  
Section H4  
Page 31 of 42
## Test Boring Log

**Boring:** TB-5 (2 of 2)

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<td>Recovery = 100</td>
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**Project Name:** Henderson Building Additions - Phase I  
**Date of Work:** 3/16/2009  
**Site:** State College Borough, Centre County, Pennsylvania  
**Driller/helper:** R. Rager/M. Rager  
**Drill Rig:** Solimax (Truck)  
**Core Bit:** NQ-II  
**Auger Type:** 3-1/4" HSA  
**Sampling Type:** ASTM D-1586  
**Elevation:** 142' +/-
# Test Boring Log

**Boring:** TB-6  
**Date of Work:** 3/11/2009

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<th>( q_p ) (tsf)</th>
<th>( M_s ) (%)</th>
<th>Remarks</th>
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<tr>
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<td>10-11-9</td>
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<td>NQ-2</td>
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<tr>
<td>Gray DOLOMITE, broken to massive, slightly weathered, hard</td>
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<tr>
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<tr>
<td>End of Boring - 21.5'</td>
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</table>

Auger Refusal - 4.5'
- Recovery = 25
- RQD = 0
- Recovery = 4
- RQD = 0
- Recovery = 100
- RQD = 40
- Recovery = 96
- RQD = 64

No Groundwater Table Encountered
APPENDIX D

LABORATORY TESTING RESULTS
Hydrometer Analysis Test Report - ASTM D422

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<th>Sieve Size (mm)</th>
<th>Percent Finer</th>
<th>Sieve Number</th>
<th>Sieve Size (mm)</th>
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Project: Henderson Building Additions - Phase I

Sample Location: Composite: TB-1 (5.0'-8.0') and TB-3 (0.5'-3.0')

Material Description: Brown Lean Clay

Client: The Pennsylvania State University

File Number: 09803

Date: 23-Mar-09

CMT I.D. No.: 9155
Hydrometer Analysis Test Report - ASTM D422

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<th>% Sand</th>
<th>% Silt</th>
<th>% Clay</th>
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<thead>
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<th>Percent Finer</th>
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Project: Henderson Building Additions - Phase I
Sample Location: TB-1 (10.0'-15.0')
Material Description: Brown Silt with Sand
Client: The Pennsylvania State University
File Number: 09803
Date: 23-Mar-09
CMT I.D. No.: 9157

CMT Laboratories, Inc.
2701 Carolean Industrial Drive, State College, PA 16801 Phone: (814) 231-8845 Fax: (814) 231-8846
www.cmtlabsinc.com
**ASTM D7012-04 (Method C): Test Method for Unconfined Compressive Strength of Intact Rock Core Specimens**

**Date Received:** 20-Mar-09  
**Date Tested:** 20-Mar-09

<table>
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<tr>
<th>Core Location</th>
<th>Depth</th>
<th>Description</th>
<th>Diameter (D) (inches)</th>
<th>Height (L) (inches)</th>
<th>L/D</th>
<th>Total Load (lb)</th>
<th>Test Temperature (°C)</th>
<th>Compressive Strength (c) (psi)</th>
<th>Type and Sketch of Fracture</th>
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**Notes:**
1) Cores were tested in the as-received condition (dry).
2) The specimen from TB-3 (15.4'-15.8') was tested with a length to diameter ratio of less than 2:1 due to the presence of irregular calcite pockets.
APPENDIX E

TYPICAL BELOW GRADE WALL BACKFILLING DETAIL
COMPACT IN FOUR (4) INCH LIFTS ACCORDING TO "STRUCTURAL FILL PLACEMENT" SECTION

SLOPE FOR STABILITY

CLAY CAP

PennDOT 2A

\[ q = \text{SURCHARGE PRESSURE} \]

\[ \sigma_x = \text{LATERAL PRESSURE} \]

*NO SCALE*

TITLE: TYPICAL BELOW GRADE WALL BACKFILLING DETAIL

PROJECT: HENDERSON BUILDING ADDITIONS - PHASE 1

CMT PROJECT #: 09803

PROJECT ENGINEER: PAUL R. THOMAS, EIT

DRAFTSPERSON: PAUL R. THOMAS, EIT

DATE: MARCH 25, 2009
APPENDIX F

BIBLIOGRAPHY
BIBLIOGRAPHY


SECTION H5 – BIM REQUIREMENTS [C]

BIM REQUIREMENTS

1. Introduction

Building Information Modeling has proven to be an effective tool in increasing the efficiency of the design and construction process throughout the industry. Penn State University (PSU) and Massaro Construction Management Services LLC (MCMS) have embraced this technology and process and are committed to its use during the Henderson Bridge Phase 1 project. While there are many uses of BIM, this project will focus on 3D coordination, 4D scheduling, and record documentation. The intent of this document is to provide clarity about MCMS’ BIM process, and the requirements for participating in that process.

2. BIM-Based Trade Coordination

A. Modeling requirements for Primes

MCMS will implement a collaborative BIM process on this project for the coordination of the trades specified in Section 8 of this document. The purpose of the BIM-based coordination effort is to reach agreement on the usage of space for components installed by the different Primes, access space, and clearance space. In this coordination process, the Primes are required to provide 3D models, called Shop Drawing Models, of their scope of work. Section 8 provides the minimum requirements for the objects that need to be represented in the Shop Drawing Models of the respective Primes. The Primes are to represent all objects and space requirements in the model that are necessary to coordinate their Scope of Work with the other trades (see Section 8 for further definition of required model elements). A Prime Contractor may be appointed by MCMS to lead the BIM coordination process under the supervision of the MCMS Virtual Construction Coordinator (VCC). Each Prime Contractor's cost of participation in the BIM process as outlined in this Requirement will be included in their bid price unless otherwise explicitly approved by MCMS.

If the Prime Contractor does not have the in-house capability to produce the required Model/Models, the Prime may utilize the service of an outside entity to provide the model/models. In the event that the Prime wishes to exclude the preparation of the Model/Models from their scope of work, they must do so at bid time and must receive approval from MCMS. The Prime must still provide electronic shop drawing files as directed by MCMS to support the coordination process in (.dwg) file format. MCMS will engage a third party on behalf of the Prime in order to convert the 2D shop drawing information into (a) 3D Shop Drawing Model/Models for coordination purposes. Any and all costs associated with this work on behalf of the Prime will become the responsibility of the Prime. This does not excuse or exclude the Prime from any of the BIM-based coordination process as described in this Requirement.

B. Structuring the models

The Shop Drawing Models need to be broken down into areas/zones that correspond to the general sequence of the coordination process as directed by MCMS, and color coded per the MCMS guidelines defined in the Project BIM Execution Plan in order to provide delineation between systems. Prime Contractor's will produce a separate Shop Drawing Model (as a single file) for each specific trade, level, and/or area/zone of the building. The practice of breaking down a model by different trades, levels, and areas/zones serves multiple purposes: (1) the general sequence of the coordination process can be followed in which the team breaks up the building into different areas, coordinates these areas and signs-off on the coordination of these areas; (2) the models provided by the different project participants are distinct so no two Primes need to work on the same model or file and their contributions can be clearly delineated; and (3) the file sizes of the Shop Drawing Models remain small and manageable for all project participants. The break down structure of the Shop Drawing Models will be determined in the Project BIM Execution Plan, as defined in Section 3, will be a collaborative process involving the entire Project Team to develop the details of the BIM process.
C. **Models are a contract for installation space**

For the purpose of field installation the final, signed-off Shop Drawing Models are treated as a contract for space. By modeling their components and Scope of Work, including access space, etc., Primes reserve space. If a conflict arises in the field installation, the Prime who did not reserve space for their components has to relocate their components at their own cost or bear the cost of relocating the Prime’s components that did reserve the space. Components that are not represented in Shop Drawing Models will be installed after the components that are represented in the signed-off Shop Drawing Models.

D. **The modeling and coordination sequence**

The sequence and schedule of the coordination process is determined by the MCMS Project Manager on the project. All models and drawings will be developed in the time frames allotted and submitted so as to not delay the installation or the overall project schedule.

In general, the traditional sequence of coordination (Ductwork, Pitched Pipe, Pressure Pipe, Electrical, and Fire Protection) will be followed. Exceptions to this sequence may be necessary in certain cases. Each trade will be assigned specific work zone elevations (top and bottom) to run racks and mains. The assigned trade(s) will take precedence in their specific work zone. When a trade must impede another trade’s work zone the following items will be given precedence (additional rules may be instituted/modified at the first coordination meeting):

- Immovable objects (equipment pads, hoods, shafts)
- Graded piping routed throughout floors (waste, storm drainage, high purity)
- Items coordinated with structure (duct penetrations shown on structural)
- Items located in their designated area (piping zone, pipe rack, cable tray)
- Items that require access (VAV’s, shut off valves, fire/smoke dampers, etc.)

When practical, and unless otherwise noted in the bid packages and contract agreements, the HVAC Prime will be given priority for placing ductwork, and should publish an initial Base Ductwork Shop Drawing Model with the major trunk lines which will serve as the basis for the other trades to begin their individual models. This should happen at the beginning of the coordination process for each given area(zone), and Base Ductwork Shop Drawing Models should be provided by the HVAC Prime at least 3 weeks prior to the first coordination meeting for that particular area/zone.

E. **The model sharing, clash detection, and coordination process**

Figure 1 illustrates the BIM-Based Coordination Process.
The process starts with the designers or 3rd party modelers (who model the design documents) providing the Architectural and Structural Design Models and uploading these models to the MCMS file sharing platform. Design Models will be made available to all project participants for use as background/reference models for laying out and coordinating their Scope of Work through the creation of 3D Shop Drawing Models. Design Models provided by MCMS will only include basic architectural features such as floors, rough approximation of ceilings, chases, door openings, partitions, exterior wall surfaces, window openings, roofs, elevator shafts, and stairs, and basic structural features such as slabs and walls, steel framing – columns and beams – and major structural elements. Each Prime is ultimately responsible for coordinating to all information contained in the 2-Dimensional Contract Drawings and Specifications as related to their work. The model(s) MCMS will provide are to be used as diagrammatic representation only and not to be relied upon for their accuracy or as an accurate representation of the design, design intent, or existing conditions. The Primes are not required or encouraged to wait for the distribution of the 3D Design Models by MCMS to begin their engineering, drafting, and coordinating efforts. Each Prime will proceed with the most haste using the 2-D contract documents to begin their engineering, drafting, and coordinating in order to meet the project schedule.

MCMS will make the following material available to the Primes on a file-sharing site. All Primes will be required to sign a release for use of these materials.

<table>
<thead>
<tr>
<th>Model</th>
<th>Author</th>
<th>File Format</th>
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</thead>
<tbody>
<tr>
<td>Architectural Design Model</td>
<td>MCMS</td>
<td>DWG</td>
</tr>
<tr>
<td>Structural Design Model</td>
<td>MCMS</td>
<td>DWG</td>
</tr>
<tr>
<td>2D Construction Documents</td>
<td>BCJ</td>
<td>DWG, PDF</td>
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Following the agreed upon coordination sequence the Primes will develop the layout of their Scope of Work and upload their Shop Drawing Models to the MCMS file sharing platform 24 hours prior to the coordination meeting. In accordance with an agreed upon schedule to be defined in the Project BIM Execution Plan (usually weekly), MCMS will download the latest Models from the file sharing platform and create a Federated Model.

A Federated Model is a model that aggregates the various Design and Shop Drawing Models provided by the project participants and allows delineating these Models from each other in the aggregate representation. The software in which the Federated Model is created, Navisworks Manage, allows automated and efficient identification of the physical clashes between the Design and Shop Drawing Models. The MCMS VCC will run the clash detection discipline by discipline and create a Clash Report that describes clashes identified in the Federated Model.

This Clash Report will be made available to all project participants on the MCMS file sharing platform before each coordination meeting. The clashes identified in the Federated Model and the Clash Report will be the basis of discussion during the coordination meeting, and a strategy for resolution of clashes will be agreed upon. The Primes are required to bring their laptop computers, with relevant software installed (ie. source modeling program such as AutoCAD MEP with Quickpen, CADPipe, CADDuct, CADMech etc. as well as Navisworks Manage), such that smaller clashes can be resolved directly at the coordination meeting. For clashes that require more re-modeling work, a conceptual solution will be developed and documented in the coordination meeting and the Primes will make adjustments to their Shop Drawing Models in their home offices. The coordination process is an iterative process that requires weekly in-person coordination meetings, which will be defined in the Project BIM Execution Plan. Additional, web-based coordination meetings may be conducted with all project participants, or between individual Primes as necessary.

If conflicts or interferences in the coordination process cannot be resolved satisfactorily, the Architect/Engineer will be notified and their decision obtained.
F. Responsibilities of the Primes in the clash detection process
During the coordination process, MCMS requires the Primes to upload their models on a frequent basis as they are being developed to the provided MCMS file sharing platform. Uploads may be requested on a frequency of between once a week to daily depending on the requirements of the project, and will be outlined in the Project BIM Execution Plan. This frequent sharing of the work as it is being developed allows the Primes to make themselves familiar with the constraints of the project early and voice possible concerns before the predecessor trades finalize their work.

It is MCMS’s intention to create an environment in which clashes in the models between the trades are proactively avoided, rather than identified and resolved in the iterative process. MCMS therefore requires Primes to utilize Navisworks Manage to internally coordinate their own Shop Drawing Models and Shop Drawing Models of other trades. This shall be achieved with frequent correspondence by all involved trades, on a daily basis if necessary, to ensure that the models have been initially coordinated prior to attendance at the coordination meetings.

The purpose of the modeling and coordination process is to develop a layout that works for all trades participating in the project, not just for the trade(s) leading in the coordination process. It may therefore be necessary that portions of the model that have been developed need to be re-configured and re-coordinated to accommodate for constraints that were not obvious until a later point in time in the coordination process. This re-configuring and re-coordination is a normal part of the coordination process, and any related costs will be borne by each relevant Prime Contractor.

The BIM-Based Coordination Process does not change the fundamentals of the coordination process. MCMS will develop the Architectural and Structural Design Models (per Section 2.E. 2nd paragraph) and the Primes will create the trades Shop Drawing Models per Section 8. MCMS does not create design or shop drawing information. MCMS’s role is to facilitate an efficient coordination process and ensure the constructability of the project. Upon completion of the 3D BIM-Based Coordination Process, and only after all parties have signed off on the coordination of an area, the Primes shall derive their 2D shop drawings from their respective 3D Shop Drawing Models for submission in accordance with the Contract Documents.

G. Maintaining the Models and Drawings, Changes, and As-Builts
All Primes are required to install their components in the spaces that they reserved in the model-based coordination process so that the coordinated and signed-off model becomes the As-Built model and the coordinated drawings become the As-Built drawings.

In the event that design changes are issued by bulletin which results in changes to the model/models, it is the responsibility of the Prime to make any and all changes required for coordination of their Scope of Work and compliance with the design. If changes or adjustments become necessary, these changes or adjustments need to be represented in the respective Shop Drawing Model(s), checked for constructability in the Federated Model and coordinated with MCMS and the other Primes involved in the coordination effort. Only after MCMS’s review and approval of the updated Shop Drawing Model shall changes be implemented in the field.

A final As-Built Model will be provided by each Prime after installation of each area/zone is complete. It is the responsibility of each Prime to produce an accurate As-Built Model based on actual field conditions and installation, and to incorporate all RFI’s, change orders, bulletins etc. that have altered the Shop Drawing Model in any way. This As-Built Model shall be provided in the native file format, *.dwg file format, and *.nwd file format.

It is the Prime’s responsibility to ensure consistency between their Shop Drawing Models and drawings at any point in time. As-Built Shop Drawing Model uploads may be requested on a frequency of between once a month to daily depending on the requirements of the project, and will be defined in the Project BIM Execution Plan.
3. The BIM Setup Process

The setup process for BIM-Based Coordination will involve the lead coordinators of each of the project participants listed in Section 8 and will comprise the following activities:

- BIM Kick-Off Meeting (all participants involved)
- Development of the Project BIM Execution Plan (multiple meetings – all participants involved).
  This will be a working document throughout the life of the project, which will be updated and changed if required and mutually agreed upon, and will include the following:
  - Naming of Project participants
  - Definition of BIM goals and uses for the Project
  - Prime Contractor BIM roles, responsibilities, and staffing
  - BIM process design maps
  - BIM information exchange requirements
  - BIM and facility data requirements
  - Collaboration procedures including meetings, model delivery schedule, and interactive workspace
  - Electronic communication procedures using file sharing platform including folder structure
  - Quality control including types of QC checks and model accuracy and tolerance
  - Technological infrastructure needs including Project participant software and hardware utilized
  - Development of the coordination sequence and the coordination schedule
  - Model structure including file naming conventions, layering definition, separation of model into areas/zones, coordinate system, measurement system, origin point, and BIM/CAD standards
  - BIM project deliverables

- Setup of the file sharing platform (done by MCMS)
- Proof of concept of the interoperability of the different modeling systems used on the project (all participants involved)
- Proof of concept of the functionality of the MCMS file sharing platform (all participants involved)
- Development of file format exchange protocols and installation of Object Enablers (all participants involved)
- Navisworks Manage training for model review and clash detection (participants as necessary – Primes responsible to get software training from vendors as necessary)

Typically, it takes 3 weeks after the BIM Kick-Off Meeting until the systems of the Project participants are setup in a way so that they can efficiently exchange files.

4. Modeling, Model File, and Drawing File Requirements

The Primes will provide their files in a file format that is useful for the coordination team for spatial coordination. The minimum requirements for the Shop Drawing Model files are the following:

- All files will be AutoCAD *.dwg file format with components of the Prime’s scope represented as 3D solids or 3D surface models (not line or wire frame models). In addition all *.dwg files shall be saved down to the lowest common AutoCAD version which will be defined in the Project BIM Execution Plan. The use of formats and versions other than *.dwg needs to be coordinated with MCMS’s VCC.

- All files will be readable by other trades’ CAD systems and Navisworks. Being ‘readable’ means the ability to open a file without any errors (such as prox, xref resolution, geometry errors, etc.) and with objects, layers, and other file properties remaining intact.

- The coordinate system and x,y,z origin point for all Model(s) will be determined in the Project BIM Execution Plan, and will be adhered to at all times by all Primes. As a default the coordinate system of the Structural Design Model will govern. A typical origin would be the center of the field (X,Y) as indicated on drawing A1-0 Work Point #1, with (Z) elevation at 0’ above mean sea level, which should match building elevation at 0’.

- All 3D model files and 2D drawing files (i.e. for coordinated composite drawings, shop drawings and installation drawings) will use the same coordinate system and origin point. 3D Shop Drawing
Model files and 2D Shop Drawing files should be one and the same file, with the annotation layers turned off in the 3D model file representation.

- Model coordination files will be saved to the MCMS file sharing platform for access by all Primes, MCMS, and the owner’s representative. The folder structure, which will be defined in the Project BIM Execution Plan, will always contain a “Latest Model” file. It will be the Trade Contractor’s responsibility to maintain the latest models in the correct file folder at all times.
- The layering standards of the submitted model files shall follow AIA layering standards, and will be defined in the Project BIM Execution Plan.
- Access spaces and clearance spaces represented in the model need to be represented on a layer named CLEARANCE.
- Annotations must be on layers separate from layers containing 3D geometrical information and have to be designated as annotation layers.
- The breakdown structure of the Models and the names of the corresponding files will be determined in the Project BIM Execution Plan.
- The building elements represented in the Models need to be of a granularity that corresponds to the anticipated method of installation – for both 3D coordination purposes and so that the model can be linked to a schedule for 4D simulation of the construction process.
- Model file names will comply with the naming structure as defined in the Project BIM Execution Plan. An example would be:
  - “FPXXX27L2.dwg” where “FP” designates the trade, “XXX” is the three letter abbreviation for the Prime (assigned by MCMS), “27” indicates the Area/Zone location, and “L2” indicates the level number.

5. Hardware and Software Requirements

Requirements for coordinators:
- Each coordinator’s / detailer’s computer will be loaded with the relevant modeling software and latest version of Navisworks Manage.
- Each coordinator’s / detailer’s computer will have hardware of sufficient capacity to handle any Model file being produced for the Project.
- Each lead coordinator will have a laptop that meets the above requirements.
- Each coordinator will have a functional email address.
- Each coordinator will have an internet connection from both the home and field office that allows general internet access, access to collaboration tools (ie. GoToMeeting) and access to the MCMS file sharing platform.

6. BIM Training and Support

Throughout the project duration MCMS’s designated VCC will be the direct point of contact for all Primes for BIM related questions. The VCC will establish the protocols for efficient file sharing and hold training/information sessions for items related to the Project BIM Execution Plan like using the MCMS file sharing platform.

7. Sign-Off and Coordination Drawing Requirements

Final 2D coordination drawings generated from the fully coordinated and approved 3D Shop Drawing Models will still be required as record documents. For the Project it is the HVAC Prime’s responsibility to assemble the 2D coordinated composite drawings for sign-off. Each Prime/trade listed in Section 8 shall provide the HVAC Prime with the Shop Drawing files in dwg-format so that he/she can assemble the coordinated composite drawings. The HVAC Prime is then required to compile and plot the number of color copies of the 2D, multi-trade, coordinated drawings required by the contract documents for final review and approval by the design team or as indicated in the Contract Documents. This is required for each floor as well as each riser. These 2D files will be the same as the 3D Shop Drawing Model files used for the BIM-based coordination process, with the annotation layers turned on.
8. Minimum Requirements for Components Represented in Models and Drawings

The requirements for objects to be included in the Shop Drawing Models provided by the Primes are minimum requirements. In case of contradictions in the scope descriptions below, the case that imposes the greater duty on the Prime shall govern.

A. General Requirements

- The Primes will provide all objects in their models that are necessary for the coordination between the trades.
- All elements must be drawn to scale and shall be a true/accurate representation of what is to be installed in the field in all three dimensions, with real-world sizes and coordinates.
- All elements must have identifiable designations including material type, part designation, size, manufacturer, and model number. In addition to these designations, all equipment shall also have serial number designations.
- Each Prime is responsible for protecting access zones within their Models. Access zones should be modeled in 3D at 80% transparency so as not to obscure the main fixture or element being protected.

B. MCMS Architectural and Structural Design Models

- Basic architectural features such as floors, rough approximation of ceilings, chases, door openings, partitions, exterior wall surfaces, window openings, roofs, elevator shafts, and stairs
- Basic structural features such as slabs and walls, steel framing – columns and beams – and major structural elements

C. General Trades Prime Structural Shop Drawing Models

- (deleted text) [C]
- All structural steel will be modeled and will represent an "as fabricated" fully detailed level of information. The fabrication level detailed model will include, but is not limited to, major structural members such as trusses, beams, columns, etc, as well as secondary and miscellaneous steel connections including gusset plates, bracing, angles, knife plates, etc necessary for the successful coordination of other building trades.

D. HVAC Prime Shop Drawing Models

- HVAC Sheetmetal
  - All ducts, related accessories (including but not limited to standard dampers, fire dampers, VAV boxes, diffusers, return air ducts, turning vanes, flanges, connections etc.) and HVAC equipment will be modeled.
  - Ducts will be modeled to the outside face dimension including duct insulation.
  - Hangers will be modeled unless their installation will not impact the coordination of any other trades.
  - All structural supports including strongback angles and unistrut supports will be modeled at full scale.
  - Access zones will be modeled for all elements requiring access including but not limited to equipment, fixtures, standard dampers, fire dampers, VAV boxes, diffusers, turning vanes, fan coil units etc.
  - All equipment will be modeled to its accurate height, width and depth dimensions.
  - Equipment pads with accurate dimensions will also be modeled.
  - All access panels will be modeled, including access zones above and below.
  - In the event that seismic bracing for suspended elements is required by code, such bracing will be included in the model.

- HVAC Piping
  - All piping, related accessories (valves, valve chains, air vents, drain valves, flow meters, etc.) and HVAC equipment will be modeled.
  - Pipes will be modeled to the outside diameter of the pipe including pipe insulation.
o Hangers will be modeled unless their installation will not impact the coordination of any other trades. All spring hangers will be modeled including anchoring devices, regardless of whether they impact other trades.

o Equipment will be modeled to its accurate height, width and depth dimensions. Equipment pads with accurate dimensions will also be modeled.

o Access zones will be modeled for all elements requiring access including but not limited to equipment, fixtures and valves.

o All access panels will be modeled, including access zones above and below.

o In the event that seismic bracing for suspended elements is required by code, such bracing will be included in the model.

o Trays for the protection of electrical equipment, if allowed by code, will be modeled.

E. Plumbing Prime Shop Drawing Models

- All plumbing, specialty piping, medical gas systems, gas systems, fittings, related accessories (valves, cleanouts, air vents, drain valves, flow meters etc.) and equipment will be modeled. Plumbing fixtures will be modeled as part of the architectural model.

- Pipes will be modeled to the outside diameter of the pipe including the pipe insulation. Pipe slope will be incorporated in the model.

- Hangers will be modeled unless their installation will not impact the coordination of any other trades.

- Equipment will be modeled to its accurate height, width and depth. Equipment pads with accurate dimensions will also be modeled.

- Access zones will be modeled for all elements requiring access including but not limited to equipment, fixtures, valves and cleanouts.

- All access panels will be modeled, including access zones above and below.

- In the event that seismic bracing for suspended elements is required by code, such bracing will be included in the model.

- Trays for the protection of electrical equipment, if allowed by code, will be modeled.

F. Electrical and Telecommunications Primes’ Shop Drawing Models

- All conduit 1” and larger (including racks of two or more conduits regardless of size), power feeds to equipment, switch gear, transformers, panels, distribution boxes, junction boxes, cable trays and pull station locations will be modeled.

- Hangers will be modeled unless their installation will not impact the coordination of any other trades.

- Light fixtures with accurate height, width, and depth dimensions and space requirements to be included in the model and coordinated with reflected ceiling plan. All access zones or clearances to maintain light fixtures will also be modeled.

- Access zones for equipment, cable tray, electrical panels, j-boxes to be included in the model.

- Equipment will be modeled to its accurate height, width and depth. Equipment pads with accurate dimensions will also be modeled.

- Equipment and junction box access zones per specification and code (which ever is greater) will be modeled. Specialty systems (gen. sets, UPS, ATS, etc.) will be modeled.

- All access panels will be modeled, including access zones above and below.

- In the event that seismic bracing for suspended elements is required by code, such bracing will be included in the model.

- All structural supports and racks utilizing unistrut, angle iron, etc. will be modeled.

- Hangers will be modeled unless their installation will not impact the coordination of any other trades.

G. Fire Protection Prime Shop Drawing Models

- All components of the fire protection system will be modeled including risers, mains, and branch piping, valves, fittings, drains, test connections, sprinkler heads, fire pumps, tanks etc.

- Access zones will be modeled for all elements requiring access including but not limited to equipment, fixtures, valves and controllers.
• Locate all piping, valves, fire pumps, and sprinkler heads.
• Equipment will be modeled to its accurate height, width and depth. Equipment pads with accurate dimensions will also be modeled.
• All access panels will be modeled, including access zones above and below.
• In the event that seismic bracing for suspended elements is required by code, such bracing will be included in the model.
• Hangers will be modeled unless their installation will not impact the coordination of any other trades.
• Trays for the protection of electrical equipment, if allowed by code, will be modeled.

9. Contract Documents and Legal Aspects

A. Any model(s) provided by the design team or MCMS (whether internally created or created by 3rd party modelers), which are subsequently provided to the Primes, are not Contract Documents as that term is defined herein. In all cases, it is the Prime's responsibility to determine if the model(s) agrees with the Contract Documents. Primes must, within fourteen (14) days of receipt of the later of any Model(s) and the corresponding Contract Documents, report all discrepancies and inconsistencies to MCMS between the Model(s) and the Contract Documents. Immediately thereafter, MCMS requires coordination of the systems listed under Section 8 herein, at the Prime's sole cost and expense, including the necessary addition of any information required for coordination from the Contract Documents in the Model(s) provided.

B. The requirement to provide coordinated and signed off drawings as outlined in the Contract Documents remains unaffected by the requirements and provisions described herein.

C. To the extent the Prime must modify or add to the Model(s) provided, the Prime grants an exclusive copyright license for the newly created and/or modified Model and model components, including the right to sell the model(s) or parts of it for any purpose whatsoever. MCMS does not waive any of its intellectual property rights and shall have the sole and exclusive right to use the BIM and all submissions made by Prime as it deems appropriate, whether during or after construction.

D. Prime agrees to use those model(s) created by/through MCMS, and their own modifications of those model(s), at their own risk and without liability to MCMS, its employees, its consultants, and their employees. Prime acknowledges and agrees that MCMS shall incur no responsibility or liability with respect to the BIM or the use thereof, including that resulting from errors, omissions or deficiencies in the BIM.

E. In the event that the Prime provides deficient information or data that does not represent the Work it will be ultimately providing, that is corrupted, that contains a virus and/or that otherwise damages the BIM, the Prime shall bear all costs associated with reconstructing the BIM and to otherwise remediate such deficiencies or their effects, and Prime shall correct the deficiency within 1 week of its discovery.

F. Prime Contractor also agrees that neither the BIM nor the use of the BIM is in lieu of nor intended to relieve the Prime of its responsibilities under the Contract, including to (i) coordinate its Work with the work of others involved in the Project and (ii) strictly comply with the other requirements of the Contract Agreement and the Contract Documents.

G. It is expressly understood that no party shall be liable to the other for any claim, dispute, controversy, cost or expense arising solely out of the use of the BIM.

END OF SECTION
THE PENNSYLVANIA STATE UNIVERSITY
DEPARTMENT OF ENVIRONMENTAL HEALTH AND SAFETY

ASBESTOS CONTAINING MATERIAL REMOVAL
PERFORMANCE SPECIFICATION FOR:

University Park Campus
Henderson Connector Demolition

PSU - OPP Project # 06 – 42744

PREPARED BY:

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June 29, 2010
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I. **General Requirements**

A. This specification covers the removal and disposal of Transite sheeting and ducting, spray or trowel-applied materials, ceiling tiles, thermal pipe insulations, boiler breaching or any other material that has been determined, by the University, to contain asbestos.

B. The Contractor shall furnish all labor, materials, services, insurances and equipment necessary to carry out the removal and disposal operations.

**NOTE:** Asbestos contractors must be on the Penn State Office of Physical Plant's Prequalified Bidders List prior to bidding.

C. The current issue of each of the following documents shall govern. Where conflicts between these specifications and the following regulations exist, the more stringent shall apply.

1. **Regulations.** Contractor(s) shall comply with the most recent, applicable Federal, State and Local regulations.

   Title 29, Code of Federal Regulations, Section 1910.1001, Occupational Safety and Health Administration (OSHA), U.S. Department of Labor.

   Title 29, Code of Federal Regulations, Section 1926.1101, Occupational Safety and Health Administration (OSHA), U.S. Department of Labor.


   Title 25, Part I, Subpart C, Article III, Chapters 123, 133, 137, Pennsylvania Department of Environmental Protection (DEP).


   Clean Water Act - U.S. Environmental Protection Agency.

   Federal and Pennsylvania Departments of Transportation.


D. **Definitions**

   **HEPA Filtered Vacuum** - High Efficiency Particulate Air (HEPA) filtered vacuum equipment capable of collecting and retaining asbestos fibers, at a minimum efficiency of 99.97% for fibers 0.3 microns or larger.
**Surfactant** - a chemical wetting agent added to water to improve penetration into asbestos containing materials.

**Critical Seal or Critical Barrier** - a barrier, consisting of two layers of 6-mil plastic sheeting sealed with tape and/or spray glue, used to prevent air entry or escape into or from the work area for the duration of the project. Critical seals shall be used to cover items such as doorways, windows, electrical fixtures, heating and ventilation louvers, immovable objects or any other object deemed necessary by the University.

**Airlock** - a system permitting passage to and from an asbestos work area preventing air movement from a contaminated area to an uncontaminated area, consisting of curtained doorways at least (3) feet apart.

**Curtained doorway** - a device to allow passage from one room to another while permitting minimal air movement between the rooms, constructed in one of the two manners:

1. Two or three overlapping sheets of 6-mil plastic over an existing or temporarily framed doorway; securing each along the top and one vertical edge of each sheet. Each sheet shall be secured along the opposite vertical side of the other.

2. Three overlapping sheets of plastic the outermost sheet attached on the top; the middle sheet attached on all sides with a vertical slit cut vertically down the center; and the innermost sheet attached on top and weighted on the bottom to fall against the middle sheet in the event of a loss of negative pressure.

The Contractor may select either of the above options; however, the Contractor must demonstrate to the satisfaction of Environmental Health and Safety that adequate directional air flow is provided with the option selected.

**Worker Decontamination Enclosure System** - a series of connected rooms, with curtained doorways to adjacent rooms, consisting of a clean room, a shower room and an equipment room. The system shall be constructed with two layers of 6-mil plastic and shall be watertight. Tape and/or glue seams shall NOT be placed on the bottom of the system.

**Equipment Decontamination Enclosure System** - a series of connected rooms with curtained doorways between adjacent rooms, consisting of a designated area in the work area, a washroom, a holding area and an uncontaminated area. The system shall be constructed with two layers of 6-mil plastic and shall be watertight. Tape and/or glue seams shall NOT be placed on the bottom of the system.

**Clean Room** - an uncontaminated area or room within worker decontamination enclosure system; with provisions, when possible, for the storage of workers clothing and protective equipment.

**Shower Room** - a room between the clean room and the equipment room in the worker decontamination enclosure system. The shower room shall have supplies such as soap and shampoo for proper employee decontamination when exiting the work area.

**Equipment Room** - a contaminated area or room in the worker decontamination enclosure system, with provisions for storage of contaminated clothing and equipment.

**Washroom** - a room between the work area and the holding area in the equipment
decontamination enclosure system. The washroom shall have provisions (water, rags, clean disposal bags) to decontaminate waste, equipment, etc., as it exits the work area.

Environmental Health and Safety (EHS) - 6 Eisenhower Parking Deck, The Pennsylvania State University, University Park, PA 16802. Phone: (814) 865-6391, Fax: (814) 863-7427.

Office of Physical Plant (OPP) – Physical Plant Building, The Pennsylvania State University, University Park, PA 16802. Phone: Contact the Project Manager or Coordinator for the project.

Penetrating Encapsulant - liquid sealant designed to be applied to materials to penetrate the material, bind its components together, and prevent fiber release. The encapsulant shall be approved by the University prior to use.

Bridging Encapsulant - a sealant material which surrounds or embeds asbestos fibers in an adhesive matrix, creates a membrane over the surface and prevents fiber release. This encapsulant shall be approved by the University prior to use.

Work Area - a room, a section of a room or other designated space in which asbestos abatement is being conducted or as defined by Environmental Health and Safety.

Work Plan – a written plan prepared by the contractor which details the scope-of-work as understood by the contractor, proposed containment and worker decontamination enclosure unit design, work phasing, scheduling, etc.

Ladders and Scaffolding - metal and wooden ladders shall be prohibited in the work area during asbestos abatement. Wooden planked scaffolding will also be prohibited.

Airless Sprayer - an electrical or hand pressurized liquid spray applicator used to apply amended water and encapsulant. Airless sprayers shall NOT be used for “Power Washing” or “Power Stripping” asbestos containing materials from the work area.

E. Submittals and Notifications

1. Contractor Information To Be Submitted With Bid Proposal

   NOTE: Asbestos contractors must be on the Penn State Office of Physical Plant’s Prequalified Bidders List prior to bidding.

a. Documentation, to Environmental Health and Safety, that all employees and supervisors conducting asbestos abatement activities have attended a PA and EPA accredited Asbestos Worker or Supervisor Training program; valid proof of which (photo ID or documentation issued by PA Department of Labor and Industry) must be presented before anyone will be allowed to work on any asbestos removal activities

   Note: For removal projects that entail only non-friable, tar-based roofing and caulking from the exterior areas of buildings, an OSHA/EPA “Competent Person” can be substituted for a PA licensed “Supervisor” (i.e. Asbestos Supervisor License from other accredited state programs).
b. Documentation, to Environmental Health and Safety, that the Contractor is licensed by the PA Department of Labor and Industry (except for removal projects that entail only non-friable, tar-based roofing and caulking from the exterior areas of buildings); and Allegheny and Philadelphia Counties (if needed).

c. The Contractor may select the disposal site for the asbestos waste material. However, this site shall be approved by Environmental Health and Safety and the appropriate state authority. The Contractor shall submit, to Environmental Health and Safety, written verification from the regulating state agency in which the landfill is located stating their approval of this site; as well as, site location, license number, telephone number, etc.

d. The Contractor may choose to use a contracted asbestos waste hauler. However, the hauler shall be approved by Environmental Health and Safety and the appropriate state authority. The Contractor shall submit, to Environmental Health and Safety, written verification from the regulating state agency in which the hauler is located stating their approval of the hauler; as well as, office location, hauler license number, telephone number, etc.

e. The Contractor shall provide a copy of all applicable insurance certificates (including asbestos removal liability insurance, if needed) and Worker’s Compensation to Environmental Health and Safety.

f. The Contractor shall provide written verification when applicable, to Environmental Health and Safety, that all workers who will work in “contaminated” or “regulated” areas participate in a medical surveillance program as required in 29 CFR 1926.1101, OSHA Asbestos Standard for the Construction Industry.

g. The Contractor shall provide the resume’ of a foreman or superintendent(s) who will act in this capacity for the duration of the project. The foreman or superintendent(s) shall have at least one year's experience in this capacity. The Contractor shall show that this person is certified in PA for supervising asbestos abatement projects. This person must be employed by the contractor and be on the project site during all project activities.

Note: For removal projects that entail only non-friable, tar-based roofing and caulking from the exterior areas of buildings, an OSHA/EPA “Competent Person” can be substituted for a PA licensed “Supervisor” (i.e. Asbestos Supervisor License from other accredited state programs).

The University reserves the right to review and approve or reject this foreman or superintendent.

h. Submit a notarized statement describing all citations and/or violations issued by any regulatory agency or consultant concerning performance on previous abatement contracts. Briefly describe the circumstances, citing job, involved persons and agencies.

The term "violation" includes all activities which have resulted in issuance
of a Notice of Violation, administrative order, civil penalty, other monetary settlement (settlement agreement, settlement letter, letter agreement, or consent assessment), permit or license suspension or revocation, bond forfeiture, summary misdemeanor or felony conviction, pleas of guilty or no contest, or any consent agreement, consent order, consent adjunction, consent or settlement decree, or any court actions whether pending or settled.

Provide a written discussion of the outcome of any citations or violations, answer the question, "has your firm or its agents been issued a Stop Work Order on any project due to negligence within the last twenty-four months?" If "Yes," provide details as discussed above.

Answer the question: "are you now, or have been in the past, a party to any litigation or arbitration arising out of your performance on asbestos abatement contracts?" If "Yes" provide details as discussed above.

Describe any liquidated damages assessed within the last twenty-four months.

Failure to properly or truthfully report any of the required information in this section shall be considered grounds for rejection of bids or termination of contract, and removal from the University's approved bidders list.

2. Information To Be Submitted By Contractor Prior To Commencement Of Work

a. Notify the EPA Region III office (NESHAPS Coordinator), the PA DEP Harrisburg office and the PA Department of Labor and Industry, in writing, of the proposed asbestos abatement before any work commences (Typically 10 working days for EPA and PA DEP, depending on the scope-of-work, and 5 calendar days for PA Department of Labor and Industry.).

A FAX and hardcopy are to be submitted to PSU Environmental Health and Safety. (FAX copy on the same day the notification is mailed. Hard copy with the project final report or documentation.).

A FAX copy is also to be submitted to the local PA DEP office in the area where the project is to be conducted and the project air monitoring and inspection firm. This shall also be faxed the same day the notification is mailed.

Proof of Mailing: The contractor shall provide “proof of mailing” these required notifications to EHS when submitting the FAX copy. This can be in the form of a registered letter receipt, copy of the postmarked envelope, etc. A copy of an envelope with a postage stamp is not acceptable.

Emergency notifications and/or project notifications less than 5 or 10 working days shall be scheduled and/or approved by Environmental Health and Safety only. These notifications, after approval from Environmental Health and Safety, shall be FAXed to all aforementioned regulatory agencies and Environmental Health and Safety, followed by
Notifications to Allegheny and Philadelphia Counties shall be in accordance to that county’s respective regulations.

Additions, deletions or corrections to notifications shall be the responsibility of the contractor or Environmental Health and Safety, depending on the circumstances.

b. Submit to Environmental Health and Safety any required PA Department of Labor and Industry notifications when removing non-friable roofing and caulks from the exterior of buildings. This shall be FAXed to Environmental Health and Safety, followed by hard copy.

c. Submit to Environmental Health and Safety any required Allegheny or Philadelphia County Project Permit if the work is to be conducted in either county. This shall be FAXed to Environmental Health and Safety, followed by hard copy.

d. When requested, submit to Environmental Health and Safety a Work Plan which details the scope-of-work as understood by the contractor, proposed containment and worker decontamination enclosure unit design, difficult conditions, work phasing, scheduling, etc. The need for a work plan will be determined by Environmental Health and Safety on a case-by-case basis.

e. The contractor shall submit a notarized statement verifying that any vehicle used to haul asbestos waste or equipment shall not be used for hauling any other material, such as, but not limited to produce and other consumer products. The notarized statement shall also confirm that this vehicle will not be a rental vehicle.

3. Documentation and Signage Required During and After Abatement Project

a. The contractor shall provide Environmental Health and Safety, a Waste Shipment Record (WSR) or manifest for all types of asbestos waste. This shall be in a format similar to that shown in EPA NESHAPS regulations and show the total number of asbestos disposal bags, drums, tons, etc. transported from the University to the approved disposal site or contractor temporary storage area or warehouse. This shall be provided to EHS when the waste leaves Penn State property.

Then, again when applicable, the contractor shall provide Environmental Health and Safety the same WSR showing that the asbestos waste was properly transported and delivered to the approved disposal site. This shall be accompanied by a written receipt from an authorized agent of the disposal site reflecting the actual number of bags, drums, etc. received for disposal.

The WSR and receipt shall be submitted to Environmental Health and Safety no later than 45 calendar days from pick-up by the initial transporter.
b. Non-friable, built-up roofing and caulking debris is not considered “asbestos waste” and, therefore, does not need to be segregated from general roofing/construction waste.

c. Signs and barriers as required by EPA and OSHA standards shall be provided and displayed at each location where asbestos abatement is conducted. Signs shall be posted at the perimeter of the work area(s), the entry and exit, and at any barriers separating work areas from occupied areas. The aforementioned signs shall also be placed on any “asbestos waste” disposal or storage vehicles during loading and unloading of asbestos waste. Depending on the waste, transport vehicles may also need to be posted with "Municipal" or "Residual Waste" signs and "UN Class 9" placards as required by PA DEP Municipal or Residual Waste and DOT Regulations.

d. The Contractor shall, upon request, provide the results of all personal exposure monitoring air sample results to Environmental Health and Safety.

e. When working in “containment areas”, the Contractor shall maintain project worker and visitor’s logs signed by all workers and visitors, including the building owner, Architect, Engineer, or representative of private or governmental inspectors, and Contractor representatives. The logs will also note reason for entry, date and duration of time in the work area, activities in the work area, safety precautions used, protective equipment used, etc.

This Log shall be provided to Environmental Health and Safety within ten days after completion of the project.

Payment for services will not be released until all required pre and post-project original documentation, invoices, etc. are received and approved by Environmental Health and Safety. Additional copies are not to be sent to other areas departments within the University. Partial payments shall be made as needed or negotiated for larger, long term projects.

F. Personnel Protection and Decontamination

1. The contractor shall provide workers with sufficient sets of protective equipment. This shall consist of full body coveralls (including attached hood and booties), headgear, eye protection and respiratory protection, gloves, etc. Nondisposable protective clothing, footwear, and eye protection shall be left in the equipment room until the end of the project, at which time such items shall be disposed of as asbestos waste, or shall be thoroughly cleaned of all visible dirt and debris. Used disposable protective clothing shall be disposed of as asbestos containing waste.

2. Respiratory protection should consist of a minimum of Powered Air Purifying Respirators (PAPR's) for gross removal and half mask Air Purifying Respirators (APR's) for preparations, repairs, glove bag removal and final cleaning. PAPR's are suggested for all activities.
3. The contractor shall provide University Officials with approved respirators and other protective clothing as described above whenever they enter the work area. Respirators worn by officials shall be equipped with new filters or cartridges whenever they enter the work area.

The Contractor shall provide at each work area a clean and disinfected PAPR for use by authorized visitors who have not undergone approved qualitative or quantitative respirator fit testing.

4. Worker Protection Procedures:
   a. Each worker shall, upon entering the decontamination system or work area: remove street clothes in the clean room, put on a respirator and clean protective clothing, before entering the shower, equipment room or the work area.
   b. Each worker shall, upon leaving the work area: remove gross contamination from clothing, etc. before leaving the work area; proceed to the equipment room and remove all clothing except respirator; still wearing the respirator, proceed naked to the shower, clean the face, head and outside of the respirator with soap and water; remove respirator dispose of filters as asbestos waste (If filters are to be re-used, they must be sealed at the intakes.). Following showering and drying, each worker shall proceed directly to the clean room and dress in street clothes.
   c. Contaminated footwear shall be stored in the equipment room when not in use in the work area. Upon completion of asbestos abatement, dispose of footwear as contaminated waste or clean thoroughly inside and out using soap and water.

   Store contaminated protective clothing in the equipment room for re-use or place in receptacles for disposal with other asbestos contaminated materials.
   d. Workers shall not eat, drink, or chew tobacco in the work area, except in the established clean room, after proper decontamination.

   SMOKING IS PROHIBITED IN ALL UNIVERSITY FACILITIES.
   e. Workers shall be fully protected with respirators and protective clothing immediately prior to the first disturbance of asbestos-containing materials and until "Final Air" testing is completed and acceptable. Precautions may be required during preparations, depending on the condition of the material to be abated.
   f. Authorized visitors shall enter the work area wearing an approved respirator, coveralls (two sets), headcover and footwear. Each time they leave the work area, they shall remove gross contamination from clothing before leaving the work area and remove the first coverall, not the respirator, in the equipment room. Respirators and the second coverall shall be removed in the clean room.
Visitors who have not undergone approved quantitative or qualitative respirator fit testing shall wear a PAPR when entering the work area.

G. Equipment Removal and Decontamination Procedures

1. Clean contaminated containers and equipment thoroughly by wet wiping and/or using a HEPA-filtered vacuum before moving into the washroom for final cleaning and removal to uncontaminated areas.

II. Materials and Equipment

A. Materials

1. Plastic Sheeting shall be of 6-mil minimum thickness.

2. Tape shall be capable of sealing joints of adjacent sheets of plastic sheeting to finished or unfinished surfaces of dissimilar materials and capable of adhering under dry, wet, hot or cold conditions, including use of amended water.

3. Surfactant (wetting agent) shall be mixed with water in a concentration sufficient to enhance the penetration of water into the materials to be removed.

4. Impermeable asbestos disposal containers shall consist of two, 6-mil plastic bags; if needed, capable of fitting in or lining drums which are capable of being sealed (metal or fiber drums) with tightly fitting lids.

The containers (bags or drums) shall be labeled in accordance with OSHA Standard 29 CFR 1910.1001 and 1926.58, as well as, EPA NESHAPS, and DOT regulations.

5. Glovebags shall be a minimum of 6-mil thickness with attached gloves, tool pouch, proper labeling, etc.

Modification of glovebags shall be prohibited unless specified by Environmental Health and Safety.

III. Execution of Work

A. Preparation and Set-up

1. Work Area:

   a. The contractor shall isolate heating, cooling and ventilating air systems with critical seals to prevent contamination to other areas. Critical seals shall remain in place for the duration of the work, and until the "Final Air" samples are approved by Environmental Health and Safety or it's representative.

   Any portion of an operating ventilation system which distributes air into any part of a building, including but not limited to duct work, shall be isolated so as not to be part of the containment area unless approval is
b. The contractor shall seal all openings, including but not limited to corridors, windows, doorways, sky-lights, ducts, grills, diffusers, pipe chases, electrical outlets, non-removable light fixtures and any other penetrations of the work areas, with critical seals, as directed by Environmental Health and Safety or its representative.

Doorways and corridors which will not be used for passage during work must be sealed with barriers as described below. These openings shall be sealed prior to any disturbance of asbestos-containing materials (e.g. prior to the removal of ceiling fixtures, tiles, etc.).

c. Separation of Work Areas from Occupied Areas

The contractor shall separate parts of the building required to remain in use from parts of the building that will undergo asbestos removal by means of airtight barriers, constructed as follows:

(a) Build suitable wood or metal framing and apply 12 mil minimum thickness plastic sheeting on both sides.

Black plastic may be required by EH&S or its representative.

(b) Seal the plastic sheeting with tape as specified on the work area side.

d. Pre-cleaning

In the event of prior asbestos contamination, Environmental Health and Safety or its representative may require pre-cleaning of the area(s) to be covered with critical seals or barriers. HEPA filtered negative air machine installation, personal protective equipment use and curtained doorway installation over the entrance(s) to the work area may also be requested prior to precleaning.

The contractor shall preclean all objects within the work area. This will be conducted using HEPA-filtered vacuums and/or wet cleaning methods. Removable objects shall be moved from the work area to a designated location only after they are precleaned.

e. The contractor shall cover floor and wall surfaces with a minimum of two layers of 6-mil plastic on both floors and walls, sealed with tape (and glue if needed).

The first layer of floor plastic shall extend at least 12 inches up on walls, then cover walls with one layer of plastic sheeting to the floor level, thus overlapping the floor plastic by a minimum of 12 inches. Install the second layers of plastic in the same manner as the first layer, thus causing an overlapping to prevent water leakage. The first and second layers shall be installed so as to allow them to be separated or removed.
independently of each other.

The floor plastic shall be installed without seams whenever possible.

f. The contractor shall install a HEPA filtered negative air pressure system(s) at all work areas to ensure a minimum negative pressure differential of 0.02 inches of water column relative to all adjacent areas. The direction of air movement shall be towards the work area from adjacent areas. This negative differential pressure shall be maintained under all conditions.

The HEPA system(s) shall run 24 hours a day for the duration of the project, until acceptable "Final Air" sample results are received and approved by Environmental Health and Safety, and containment or work area tear down is complete.

Requirements for the installation and operation of the system are as follows:

1. Exhaust from HEPA-filtered air systems shall be ducted to the outdoors whenever feasible.
   New exhaust duct shall be used for each project; previously used duct shall be rejected on-site.

2. HEPA filter(s) shall be tightly sealed around their edges/gaskets.

3. The system shall be visually inspected and approved by Environmental Health and Safety or it's representative prior to use.

4. The procedures for use of HEPA negative-pressure systems shall conform to Appendix J of the EPA Guidance Document, "Guidance for Controlling Asbestos Containing Materials in Buildings (June 1985)."

5. The contractor shall maintain "spare" Negative Air Filtration unit(s), of sufficient air movement capacity, on site for use in the event of unit failure. These may need to be stored in the work area depending on the configuration of the containment and decontamination enclosure system(s). Environmental Health and Safety or it's representative shall determine whether the unit(s) must be stored in the work area.

If the HEPA filtration system fails, the Contractor shall immediately seal all entrances to the work area. These entrances shall remain sealed until the HEPA system is again operational.

In the event of an emergency the University may need to penetrate prepared areas to resolve the emergency. Any repairs required by these penetrations will be conducted by the Contractor at no charge to the University.

g. The contractor shall build decontamination enclosure systems at work...
area entrances and exits.

h. The contractor shall remove and clean ceiling mounted objects, such as lights and other items not previously sealed that interfere with the asbestos removal. Use localized water spraying and/or HEPA-filtered vacuum during fixture removal to reduce fiber dispersal.

i. The contractor shall maintain easily visible emergency and fire exits from the work area.

j. After preparing work areas, decontamination enclosure systems and receiving approval from Environmental Health and Safety, the contractor shall remove ceiling panels and tiles within the work areas, clean using a HEPA-filtered vacuum or damp sponge, wrap the clean tiles in 6-mil plastic and store in a location selected by the University or dispose of as contaminated waste in accordance with Section III.B of this specification.

k. Where suspended ceiling system grids, must be removed to make work accessible, the contractor shall clean the grids using a HEPA vacuum and/or wet methods, disconnect from hangers, wrap grid in 6-mil plastic and store or dispose as directed by the University.

l. All areas where asbestos-containing materials are disturbed shall be completely isolated from adjacent areas using wood framed, sealed barriers with 2 layers of 6-mil plastic sheeting on both sides of the frame.

m. The contractor shall seal elevators that may open into work areas with critical seals until “Final Air” samples have been approved by Environmental Health and Safety. Elevator shutdowns shall be the responsibility of the University.

2. Decontamination Enclosure Systems

a. The contractor shall build suitable framing or use existing rooms connected with framed-in tunnels, and line with two layers of plastic, sealed with tape at all plastic joints, for all enclosures and decontamination enclosure system rooms. The plastic shall be placed towards the contaminated area(s) so that the framing material does not become contaminated. Tape and/or glue seams shall NOT be placed on the bottom of the system.

b. In all cases, access between contaminated and uncontaminated rooms or areas shall be through an airlock. Access between any two rooms within the decontamination enclosure systems shall be through a curtained doorway.

c. **Worker Decontamination Enclosure System:**

The contractor shall construct a worker decontamination enclosure system contiguous to the work area consisting of at least three totally enclosed chambers (airlocks) as follows:

- **(1) An equipment room with two curtained doorways, one to the**
work area and one to the shower room.

(2) A shower/washroom with two curtained doorways, one to the equipment room and one to the clean room. The shower room shall contain at least one shower head for each ten (10) employees, as well as, body soap or other appropriate cleansing agents convenient to the showers.

The University shall provide both hot and cold water whenever possible. However, in the event that hot water is not available, the contractor shall supply a portable source of hot water. This unit shall be electrically powered and use 110 VAC as its power source.

Water from the shower shall be collected and filtered, using a 3 to 5 micron filter, prior to disposal into any waste water system. Water shall not be bagged as waste.

(3) A clean room with one curtained doorway into the shower and one curtained entrance to uncontaminated areas of the building. When possible, the clean room shall have sufficient space for storage of street clothes, towels, and other uncontaminated items.

d. **Equipment Decontamination Enclosure System:**

When required, the contractor shall construct an equipment decontamination enclosure system consisting of two totally enclosed chambers as follows:

(1) A washroom, with a curtained doorway to a designated area of the work area and a curtained doorway to the holding area.

(2) A holding area, with a curtained doorway to an uncontaminated area.

3. **Preparation for Glove Bag Removal of Pipe Insulation**

a. If the amount of asbestos-containing pipe insulation to be removed by the glove bag method, is less than or equal to ten (10) linear feet, the work area shall be prepared and air monitored in accordance with all sections of this specification, with the following exceptions:

1. A single layer of 6-mil plastic shall be used to construct the enclosure system. Plastic shall be installed on all walls, floors and surfaces in the work area.

2. The plastic enclosure system shall be connected to at least two airlocks serving as a decontamination enclosure system.

If any personal or area air sample collected inside the work area exceeds the current OSHA PEL for airborne asbestos, a shower shall be installed for proper worker decontamination.
3. “Final Air” samples shall be collected in accordance with this specification. Additional air samples collected outside of the work area shall be collected at the discretion of Environmental Health and Safety or their representative.

b. If the amount of asbestos-containing pipe insulation to be removed by the glove bag method, is greater than ten (10) linear feet, all requirements of this specification will apply.

c. After the removal has been completed and approved by Environmental Health and Safety, a representative number of "Final Air" samples shall be collected and analyzed in accordance with Section IV. of this specification. The number and location of samples shall be at the discretion of Environmental Health and Safety. These samples may encompass locations inside and outside of the work area.

d. The HEPA-filtration system(s) shall continue running and the enclosure shall remain intact until all "Final Air" sample results are approved by Environmental Health and Safety, and containment tear down is complete.

4. Preparation for Transite Removal (Indoor)

All requirements of this specification shall apply with the following exceptions:

a. A single layer of 6-mil plastic sheeting shall be installed on all critical barriers.

b. A single layer of 6-mil plastic sheeting shall be installed on all walls and vertical surfaces in the work area.

c. A minimum of two layers of 6-mil plastic sheeting shall be installed on all floors and horizontal surfaces within the work area and worker decontamination enclosure systems.

5. Preparation for Floor Tile and Mastic Removal and Other Resilient Floorings:


Preparation for the removal of Vinyl Asbestos Tile/Asbestos Sheet Flooring and Mastic using hand tools and chemical strippers shall include all sections of the specification, except plastic sheeting covering walls will consist of only one layer installed up to a height of (6) feet. All other requirements for critical seals, worker decontamination, negative air, precleaning, final cleaning, air sampling, etc. shall still apply.

b. Mechanical Removal - using powered tile removal equipment and shot blasters.

Preparation for the removal of Vinyl Asbestos Tile/Asbestos Sheet Flooring and Mastic using mechanical methods shall include all sections of the specification.

6. Maintenance of Enclosure System by the Contractor:
a. Visually inspect enclosures at the beginning and end of each work period, and periodically throughout the day.

Ensure that barriers, chambers and plastic linings are effectively sealed and taped. Repair damaged barriers and remedy defects immediately upon discovery.

Use smoke methods to test effectiveness of barriers when directed by Environmental Health and Safety or it's representative.

b. Asbestos removal work shall not commence until:

Arrangements have been made for waste disposal at an approved landfill site.

Work areas and decontamination enclosure systems are effectively segregated and have been approved by Environmental Health and Safety or designated representative.

Environmental Health and Safety or it's representative approves of the location, number and air flow rate (cfm) of all HEPA-filtered air pressure systems.

Environmental Health and Safety or it's representative approves the final preparation of the work area.

All other preparatory steps have been taken, applicable notices posted, and permits obtained.

B. Asbestos Removal

1. Glove Bag Removal of Pipe Insulation

a. The Contractor shall use glove bags in the manner described in the most recent EPA or OSHA standards and/or guidelines. Glove bags shall have a minimum thickness of 6-mils. Any damaged, adjacent, pipe insulation within 10 linear feet of the section to be removed, must be repaired with canvas, plaster cloth, trowel-on encapsulant or other original equipment materials prior to the start of any glove bag work.

b. Canvas, plaster cloth, trowel-on encapsulant or other original equipment materials shall be applied to all exposed ends of insulation to prevent fiber release.

c. Penetrating encapsulant shall be applied to all surfaces of pipe where asbestos has been removed.

d. Glove bags shall not be reused or slid along adjacent lengths of pipe insulation.

e. Before leaving the work area, glove bags shall be placed into 6-mil labeled polyethylene bags and sealed, for disposal.
2. Gross Asbestos Removal
   a. Prepare site (see Section III.A)
   b. Spray asbestos material with amended water before and during removal, using spray equipment capable of providing a "mist" application. Saturate the material sufficiently without causing excess dripping or delamination of the material. Spray the asbestos material repeatedly during the work process to maintain a wet condition and to minimize fiber dispersion.
   c. Remove the saturated asbestos material in small sections. As it is removed, pack the material into labeled plastic bags of 6-mil minimum thickness. Material shall not be allowed to dry prior to insertion into the bags.

Transite, removal shall be conducted so as to minimize breakage as much as possible.

Transite shall not be allowed to drop to the floor during removal.

Transite shall either be placed in labeled, plastic lined drums or double wrapped in labeled plastic for disposal. The option of which shall be at the discretion of Environmental Health and Safety or it's representative.

d. All plastic sheeting, tape, cleaning materials, clothing and other disposable material or items used in the removal shall be packed into two plastic bags of 6-mil minimum thickness each for disposal. ALL MATERIALS SHALL BE WETTED PRIOR TO DISPOSAL, INCLUDING PLASTIC, DISPOSABLE COVERALLS, ETC.

e. Seal filled bags using tape and the "goose necking" technique. "Goose necking" meaning sealing waste bags by first twisting the bags, taping, folding the twisted area over and taping again. This shall be conducted on both bags.

Ensure that bags are labeled in accordance with OSHA, EPA NESHAPS and DOT. Clean external surfaces of the bags by wet cleaning in the work area, or equipment room of the worker or equipment Decontamination Enclosure System. Move bags to the shower or washroom, wet clean the exterior of each thoroughly. After cleaning, pass the bag out of the shower or washroom and place into a second "clean" bag before moving to a uncontaminated areas. Ensure that the bags are removed from the clean room by workers who entered from uncontaminated areas dressed in clean clothing. If drums are used, ensure that the exterior of each drum is labeled in accordance with the regulations mentioned above.

f. The Contractor shall transport the sealed bags and drums, if used, to the approved waste disposal site or storage facility at regular intervals without allowing asbestos waste to accumulate inside or outside of the building.

Any asbestos waste transported through a building, elevator or stair
tower must be contained in two (2) sealed 6-mil plastic bags inside of a sealable drum or cart. Bags of waste may be taken out of the drums or carts and placed in an appropriate vehicle once the drums have been transported outside of the building.

g. After completion of gross removal, all surfaces from which asbestos has been removed shall be wire brushed and/or wet sponged, or cleaned by an equivalent method.

Additionally, clean all surfaces in the work area using wet methods and/or a HEPA-filtered vacuum.

Cleaning with leaf blowers may be required by Environmental Health and Safety or it's representative at this time.

This cleanup includes removal of all visible accumulations of material, dust and debris.

h. Upon acceptable visual inspection by the contractor's supervisor via flashlights, Environmental Health and Safety or it's representative shall be asked to inspect the area. Environmental Health and Safety or it's representative shall then conduct a visual inspection, also via flashlights, as soon as possible upon request from the supervisor. After approval from Environmental Health and Safety or it's representative, all surfaces and the inner layer of plastic shall be sprayed with a penetrating encapsulant.

i. All liquid waste produced within the work area or decontamination enclosure system shall be passed through a 3 to 5 micron filter prior to disposal into any waste water system.

3. Asbestos Containing Built-up Roofing Removal

a. Shut down HVAC intake systems and cover and seal roof-mounted HVAC intake vents with plastic and duct tape.

b. Spray asbestos material with amended water before and during removal, using spray equipment capable of providing a "mist" application. Saturate the material sufficiently without causing excess dripping or delamination of the material. Spray the asbestos material repeatedly during the work process to maintain a wet condition and to minimize fiber and dust dispersion.

c. Remove the saturated asbestos roofing material in small sections. As it is removed, immediately transfer the material to the disposal container.

Material **SHALL NOT** be allowed to dry out prior to insertion the disposal container.

d. A covered chute may be used to lower wetted roofing debris to a covered dumpster.

Note: Non-friable, built-up roofing and caulking debris is not considered
“asbestos waste” and, therefore, does not have to be segregated from general roofing/construction waste.

In some cases, disposal in labeled, 6-mil, asbestos disposal bags may be required. This shall be at the discretion of Environmental Health and Safety.

Note: Due to the nature and content of some roofing materials and the logistics of removing materials from the roof area, disposal containers may need to be more substantial than labeled plastic bags which may tear. In this case, disposal may require metal or fiber drums or simply cardboard or burlap liners for labeled plastic bags. This shall be the choice of the contractor; the final required result being that no asbestos waste containers shall be allowed to leak.

Also, in some cases, a lined dumpster may be substituted for smaller containers. This will be at the discretion of Environmental Health and Safety on a case-by-case basis.

e. All plastic sheeting, tape, cleaning materials, clothing and other disposable material or items used in roofing removal shall be packed into two plastic bags of 6-mil minimum thickness each for disposal.

ALL MATERIALS SHALL BE WETTED PRIOR TO DISPOSAL, INCLUDING PLASTIC, DISPOSABLE COVERALLS, ETC.

f. Seal filled bags using tape and the "goose necking" technique. "Goose necking" meaning sealing waste bags by first twisting the bags, taping, folding the twisted area over and taping again. This shall be conducted on both bags separately.

Clean external surfaces of the containers by wet cleaning in the work area, or equipment room of the worker or equipment Decontamination Enclosure System if used.

g. The Contractor shall transport the sealed containers to the approved waste disposal site or storage facility at regular intervals without allowing waste to accumulate.

Any waste transported through a building, elevator or stair tower must be contained in two (2) sealed 6-mil plastic bags inside of a sealable drum or cart. Bags of waste may be taken out of the drums or carts and placed in an appropriate vehicle once the drums have been transported outside of the building.

h. After completion of removal, all surfaces from which asbestos roofing has been removed shall be cleaned using wet methods and/or a HEPA-filtered vacuum.

This cleanup includes removal of all visible accumulations of material, dust and debris.

i. Upon acceptable visual inspection by the contractor's supervisor,
Environmental Health and Safety or OPP or their representative shall be asked to inspect the area. Environmental Health and Safety, OPP or their representative shall then conduct a visual inspection, as soon as possible upon request from the supervisor.

4. Transite Roofing and Siding Removal

a. Transite roofing and siding removal shall be conducted so as to minimize breakage of the material as much as possible.

Transite roofing or siding SHALL NOT be allowed to drop to the ground during removal.

Transite will be removed and treated as non-friable asbestos and as such shall require ALL asbestos licensing, waste manifesting, notification requirements, etc. as friable asbestos as referred in other sections of this specification.

b. All plastic sheeting, tape, cleaning materials, clothing and other disposable material or items used for Transite removal shall be packed into two plastic bags of 6-mil minimum thickness each for disposal.

ALL MATERIALS SHALL BE WETTED PRIOR TO DISPOSAL, INCLUDING PLASTIC, DISPOSABLE COVERALLS, ETC.

c. Seal filled bags using tape and the "goose necking" technique. "Goose necking" meaning sealing waste bags by first twisting the bags, taping, folding the twisted area over and taping again. This shall be conducted on both bags.

Since Transite is an "asbestos waste", ensure that bags, drums, etc. are labeled in accordance with OSHA, EPA NESHAPS and DOT. Clean external surfaces of the containers by wet cleaning in the work area, or equipment room of the worker or equipment Decontamination Enclosure System.

d. The Contractor shall transport the sealed containers to the approved waste disposal site or storage facility at regular intervals without allowing waste to accumulate.

Any waste transported through a building, elevator or stair tower must be contained in two (2) sealed 6-mil plastic bags inside of a sealable drum or cart. Bags of waste may be taken out of the drums or carts and placed in an appropriate vehicle once the drums have been transported outside of the building.

e. After completion of removal, all surfaces from which asbestos roofing has been removed shall be cleaned using wet methods and/or a HEPA-filtered vacuum.

This cleanup includes removal of all visible accumulations of material, dust and debris.

f. Upon acceptable visual inspection by the contractor's supervisor,
Environmental Health and Safety or OPP or their representative shall be asked to inspect the area. Environmental Health and Safety, OPP or their representative shall then conduct a visual inspection, as soon as possible upon request from the supervisor.

g. All liquid waste produced within the Transite removal work area shall be passed through a 3 to 5 micron filter prior to disposal into any waste water system.

C. Final Cleanup of Containment/Work Areas

1. After the encapsulant is dry or tacky, remove the inner layer of plastic sheeting from the walls and floors. The outer layer of plastic and critical seals on windows, doors, and HVAC vents, etc. shall remain in place, and the HEPA-filtered negative air pressure systems shall remain in service.

2. Again clean all surfaces in the work area, including the decontamination enclosure systems, and all other areas used during the asbestos removal process by wet wiping and/or HEPA vacuuming.

   Cleaning with leaf blowers may again be required by Environmental Health and Safety or it's representative at this time.

   This cleanup shall again include removal of all visible accumulations of material, dust and debris.

3. Remove the remaining layer of plastic sheeting from the walls and floors. The windows, doors, and HVAC vents shall remain critically sealed and the HEPA-filtered negative air pressure systems shall remain in service.

4. After cleaning the work area and all other areas included above, the Contractor shall have the option to wait 24 hours to allow dust to settle or be filtered and then wet clean or HEPA-vacuum all surfaces again.

   This waiting period will also allow any residual water or encapsulant to dry.

5. After the area has been cleaned as specified above, the contractor's supervisor shall again inspect all areas, via a flashlight, to determine whether all visible dust has been satisfactorily removed. If the asbestos has been satisfactorily removed, and the area satisfactorily cleaned, the supervisor shall request a visual inspection by Environmental Health and Safety or it's representative. If Environmental Health and Safety, or their representative, finds visible accumulations of debris in any of the areas, the Contractor shall repeat the wet cleaning or HEPA-vacuuming until the work area is satisfactory. Once the work area is deemed satisfactorily cleaned "Final Air" sampling can be conducted.

   a. If the results of the "Final Air" sampling are satisfactory, all remaining plastic sheeting shall be removed, placed into two plastic bags of 6-mil minimum thickness each and transported in accordance with this specification.

   (1) Satisfactory "Final Air" sample results shall be concentrations that are less than or equal to 0.005 fibers/cc using Phase Contrast Microscopy (PCM).
(2) No activities within the project area, such as replacement procedures, may commence until the area is found satisfactory by visual inspection and "Final Air" sampling.

b. If the results of the "Final Air" sampling are not satisfactory, the area shall be wet cleaned or HEPA-vacuumed and inspected until the air samples are satisfactory.

The entire work area must also be dry or "tacky" to the touch before final air sampling is to be conducted (i.e. no visible puddles or droplets of water or encapsulant).

IV. Air Monitoring and Inspection Firm Qualifications and Requirements

A. Air monitoring and visual inspections shall be conducted during indoor asbestos abatement (and outside as determined on a case-by-case basis by Environmental Health and Safety) by an independent firm, hired by the University, General Contractor or Construction Manager, in accordance with the University’s Asbestos Containing Material Removal Performance Specification, applicable NIOSH air sampling methods and the following protocol:

Air monitoring and inspection firms CANNOT be hired by the asbestos contractor.

NOTE: Asbestos air monitoring and inspection firms must be approved by EHS and OPP.

1. Qualifications of personnel conducting on-site air monitoring and visual inspections:

   Air monitoring and inspection firm on-site personnel shall have at least (6) month’s experience in asbestos abatement project inspection, air sampling and analysis. Penn State reserves the right to review, approve and/or reject these on-site personnel.

2. All air samples shall be immediately analyzed "on-site" by:

   a. An analyst whose name appears in the most recent copy of the Asbestos Analysts Registry developed by the American Industrial Hygiene Association (AIHA); or

   c. An analyst who has successfully completed the NIOSH 582 course or an equivalent, and successfully participates in the Proficiency Analytical Testing (PAT) Program, and is employed by an AIHA accredited laboratory.

2. Air monitoring specified below represents the minimum numbers of samples to be collected each day; this may be increased at the discretion of EHS.

<table>
<thead>
<tr>
<th>Minimum #</th>
<th>Minimum Sample</th>
</tr>
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</table>

Henderson – Biobehavioral Health Building
DGS 800-290/PSU 06-42744/BCJ 08001 20 September 2010
Location | Samples/Day | Volume(liters)
---|---|---
Inside decontamination unit "clean" room | 2 | 1200
Outside work area (at discretion of EHS) | 2 | 1200
Downstream of each HEPA filter exhaust | 1 | 1200

Ten (10) percent of all samples shall be re-analyzed and their concentrations confirmed at an AIHA accredited laboratory. These samples shall be randomly selected and may require approval by Environmental Health and Safety.

B. A representative number of "Final Air" samples shall also be collected, as designated by Environmental Health and Safety.

1. "Final Air" testing will be conducted under aggressive conditions whenever feasible, as directed by EHS. Agitation of the air during sampling will be by either a (1) horsepower leaf blower or stationary fans. If visible dust is disturbed at any time while using leaf blowers or fans, air sampling shall be terminated. The contractor will then reclean the area until no visible dust is seen.

2. All "Final Air" samples shall have a minimum volume of 1200 liters of air and shall show airborne fiber concentrations that are less than or equal to 0.005 fibers/cc using PCM.

3. Additional "Final Air" samples may be requested in each work area, and immediately submitted to Environmental Health and Safety. These samples shall be collected on polycarbonate filters (25-mm) with a pore size of 0.45 micrometers or less (AHERA TEM air sample filters). These samples shall not be analyzed on-site but shall be collected at the same time as the other "Final Air" samples. EHS will become the owner of these samples, which will serve as archive "Final Air" samples.

C. All area and "Final Air" samples shall be collected and analyzed by the independent air monitoring and inspection firm. The Contractor shall not collect or analyze any air samples for the University.

D. All air sampling shall be conducted in accordance with the method prescribed in applicable EPA and OSHA guidelines.

1. Air sampling pumps shall be calibrated before and after each use and record of this calibration shall be furnished to EHS.

E. Daily air samples collected outside of the work area, from the beginning of removal activities until satisfactory "Final Air" samples are attained (less than or equal to 0.005 fibers/cc).

The Contractor or the University may choose to collect background samples in
proximity to the work area, prior to the start of any preparation or removal activities. A minimum sample volume of 1200 liters shall be collected for the background samples. The samples may be analyzed using PCM (NIOSH 7400A) or Transmission Electron Microscopy (TEM).

If a sample reading above 0.005 fibers/cc is obtained outside of the work area, the Contractor shall take immediate, corrective action under the supervision of EHS or it's representative. Corrective action includes but is not limited to: collection of additional air samples, HEPA vacuuming or wet wiping of contaminated areas, and construction of additional airtight barriers.

Corrective actions shall be conducted until all samples outside the work area are once again below 0.005 fibers/cc or background concentration.

F. A written report and invoice shall be submitted to Environmental Health and Safety within 45 days of the satisfactory completion of the project. Additional copies shall not be sent to other departments within the University. EHS will distribute as needed after review and approval.

The report shall include:

a. Report/Cover Letter describing the general details of the project (i.e. scope of work, contractor representative, EHS contact, start and end dates, etc. This report should preferably be written by the person(s) on-site at the time of the work.

b. Diagram of containment area showing daily and final air test locations, containment boundary, decontamination unit and negative air machine layout, etc. Building floorplans for this purpose will be provided by PSU when possible.

c. Project monitor's daily log sheets, both hand written, and if needed for legibility, typed.

Log entries will be expected to be concise, but detailed enough so that the unfamiliar can follow job progress, conversations, decisions, etc. Entries will be made every half-hour at the minimum and must show the time of day. Logs sheets will also have the project monitor's printed name, signature and date. This information will be on all pages, which will be numbered.

d. Daily checklists for projects that require the project monitor to record number of negative air machines, manometer readings, proper glovebag use, containment integrity, etc. "No" or "unchecked" responses shall be corrected and explained fully either on the checklist or in daily logs.

e. Field sampling data sheets that contain sample number, sample date, air pump pre- and post-calibration data, sample time-on and time-off, total sampling time, average sample flow rate, sample description, location, results, etc. These shall also show project monitor's printed name, signature and date.
Typed sample data sheets may be required for legibility and ease of cataloging.

f. Air sample fiber count sheets that show the number of fibers counted in each sample and which grid the fibers were seen. These shall also show sample number, collection date, sampler's printed name/signature, date of analysis, analyst's printed name, signature and date, etc.

g. Asbestos Worker Daily Sign-In Sheet with printed names, signatures and PA Department of Labor and Industry license Number.

Those without valid photo-ID or a receipt from the PA Department of Labor and Industry shall not be allowed to conduct asbestos removal activities (Preparation activities or assistant activities outside the work are allowable.).

Anything typed or duplicated (i.e. daily logs, sample data, computer generated drawings, etc.) shall include the corresponding handwritten notes/information, data, drawing, etc. that it was transcribed from.

G. Although not required by this specification, it is highly recommended that the Contractor conduct air sampling inside the work area during preparation and removal in accordance with all applicable OSHA standards.

Prepared By: Michael J. Burke, Industrial Hygiene Specialist
PA Labor & Industry Project Designer #001970
Appendix A

ASBESTOS REMOVAL SCOPE OF WORK

**Project Duration:** Asbestos Contractor to provide duration, in days, with bid.

**Work Plan:** Asbestos Contractor to provide with bid. Plan must show planned work area layout, decon and negative air placement, phasing, etc.

**Pre-Bid Meeting:** To be scheduled by Construction Manager or General Contractor.

Asbestos Containing Materials:

1. Floor Tile – Found throughout area. Some may be under carpet, furniture and / or partition walls.
   a. Mastic is NOT asbestos.

2. Sheet Flooring and Black Edge Strips – Found on ramps to Henderson North.
   a. Mastic is NOT asbestos.

3. Pipe fitting insulations – May be found above ceilings or within walls.
   a. To be removed via wrap-and-cut and / or negative pressure glovebags, within same containments as flooring.
   b. Set up to consist of critical seals and drop cloths on floors only.

**Notes:**

1. Plastic sheeting not required on walls in flooring containment areas (only decontamination unit and critical seals on windows, doors, vents, etc).
2. Floor tile and sheet goods to be wetted and removed as intact as possible with hand tools.
3. Carpet to be removed by Asbestos Contractor. To be disposed as construction debris if floor tile not attached. If small amounts of tile attached, cut tile away and separate waste accordingly. If large amounts of tile attached dispose of all as non-friable asbestos waste.
4. Asbestos Contractor to conduct small-scale, exploratory demolition of partition walls, plaster / CMU walls, drop ceilings, etc. to locate, access and remove floor tile and pipe fitting insulation as needed.
5. Asbestos Contractor to coordinate furniture / cabinetry removal with Construction Manager, as needed.
6. Lightly encapsulate floors and walls with a **clear** product after asbestos removal and fine cleaning.
7. Blank blockplan attached for Work Plan, etc.
8. Prevailing Wages apply.

Miscellaneous Non-Asbestos Materials

**Fluorescent light tubes** – Remove and package **ALL** tubes in accordance with PSU Safety Policy SY31 LAMP USE AND DISPOSAL ([http://guru.psu.edu/policies/sy31.html](http://guru.psu.edu/policies/sy31.html)). PSU EHS will provide containers and dispose.
Appendix A - Continued

Fluorescent light fixture ballasts – Remove and dispose only PCB containing ballasts in accordance with PSU Safety Policy SY26 FLUORESCENT LIGHT BALLAST/CAPACITOR DISPOSAL (http://guru.psu.edu/policies/sy26.html). PSU EHS will provide containers and dispose.

Mercury thermostats and switches – Remove and package intact. PSU will provide containers and dispose. Coordinate electric and heat shut downs with Penn State.
## Appendix B

### Unit Price Quotation Request

In the event that unexpected Asbestos Containing Materials are discovered, in addition to the Scope of Work in Appendix A, the University also requests that a quotation be submitted for the following Unit Price Items

**(NOTE: Removal / repair related items assume a containment was / is previously constructed):**

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Construct and dismantle a 3 stage decontamination unit with clean room, shower, and dirty room.</td>
<td>_____EA</td>
</tr>
<tr>
<td>2. Construct and dismantle a 2-stage decontamination unit with clean and dirty room.</td>
<td>_____EA</td>
</tr>
<tr>
<td>3. Cover critical seals with one layer of 6-mil polyethylene sheeting.</td>
<td>_____SF</td>
</tr>
<tr>
<td>4. Cover walls with one layer of 6-mil polyethylene sheeting.</td>
<td>_____SF</td>
</tr>
<tr>
<td>5. Cover floors with one layer of 6-mil polyethylene sheeting.</td>
<td>_____SF</td>
</tr>
<tr>
<td>6. Patch and seal damaged pipe, fitting or duct insulation using patching cement, bridging encapsulant, and/or wettable fiberglass or plaster wrap.</td>
<td>_____LF</td>
</tr>
<tr>
<td>7. Glove Bag pipe insulation up to and including 4 inch OD.</td>
<td>_____LF</td>
</tr>
<tr>
<td>8. Glove Bag pipe insulation &gt;4&quot; OD up to and including 8&quot; OD.</td>
<td>_____LF</td>
</tr>
<tr>
<td>9. Glove Bag pipe insulation &gt;8&quot; OD up to and including 12&quot; OD.</td>
<td>_____LF</td>
</tr>
<tr>
<td>10. Remove asbestos ceiling / wall plasters or textured paints</td>
<td>_____ SF</td>
</tr>
<tr>
<td>11. Remove ceiling tile (asbestos or contaminated). Do not include if non-asbestos and removal required to access other materials.</td>
<td>_____ SF</td>
</tr>
<tr>
<td>12. Remove asbestos ceiling tile / chalkboard adhesives</td>
<td>_____SF</td>
</tr>
<tr>
<td>13. Remove fireproofing</td>
<td>_____SF</td>
</tr>
<tr>
<td>14. Remove floor tile / linoleum and mastic</td>
<td>_____SF</td>
</tr>
<tr>
<td>15. Remove Transite sheeting.</td>
<td>_____SF</td>
</tr>
<tr>
<td>16. Remove Tar-Based Built-up Roofing</td>
<td>_____SF</td>
</tr>
<tr>
<td>17. Remove Masonry or Window Caulking with hand tools.</td>
<td>_____LF</td>
</tr>
<tr>
<td>18. HEPA vacuum contaminated surfaces (i.e. top of ceiling tiles, crawlspace floors, etc.), in addition to standard cleaning.</td>
<td>_____SF</td>
</tr>
<tr>
<td>19. Drill holes or penetrations in asbestos flooring or ceilings with HEPA vacuum equipped drills.</td>
<td>_____ Hole</td>
</tr>
</tbody>
</table>
Appendix C

WORK PHASING / SCHEDULE / MANPOWER / WORKING HOURS

Work Phasing / Scheduling

Penn State OPP, EHS and the chosen air monitoring firm will be kept appraised of all schedules and phasing in advance of start of work.

NOTE: The air monitoring firm will not be expected to work extra hours for air sampling to “clear” work areas due to inadequate contractor planning or manpower.

Manpower

The Asbestos Contractor is expected to supply the appropriate manpower to complete the project in the allotted schedule.

If temporary labor is employed and workers’ native language is not English, the Asbestos Contractor must ensure there are an adequate number of supervisors who are fluent in the appropriate native language(s) of the workers.

Working Hours

Due to regulatory requirements, emergency egress and occupant safety issues, asbestos-related work often requires special scheduling and planning considerations.

Publicly Accessible Areas - Lobbies, Corridors, Open Rooms or Stairs

- All asbestos handling in these areas must be conducted during non-occupied hours such as nights, weekends or breaks.
- Set up can occur at any time as long as public access or egress is not impeded.
- Emergency exceptions must be evaluated and approved by EHS, case-by-case.
- Corridors and/or stairs cannot be blocked during normal occupancy or class use hours, unless there are adequate alternate emergency egress pathways.

Non-Publicly Accessible Areas – Closed Rooms, Corridors, Stairs, Renovation or Construction Areas

- Removal where decontamination units or other equipment must be placed in publicly accessible areas must be conducted during non-occupied hours such as nights, weekends or breaks (Example: decon entrance opens into occupied corridor or negative air exhaust must run through the corridor or an adjacent room).
- Set up can occur at any time as long as public access or egress is not impeded.
- Emergency exceptions must be evaluated and approved by EHS on a case-by-case basis.
Appendix D

Approved Asbestos Contractors and Site Visit Requirements

The most up-to-date listing of prequalified asbestos contractors is located on the OPP Prequalified Contractors Search webpage at:

http://apps.opp.psu.edu/BiddersList/search.cfm
Appendix E

Approved Air Monitoring and Inspection Firms

Air monitoring and inspection services are to be contracted separately by Penn State.

However, the chosen General and Asbestos Contractors will be expected to work closely and coordinate all work and scheduling with the chosen consultant, PSU OPP and EHS.
SECTION H7 – PRIME CONTRACTOR PREQUALIFICATION FORM

PROJECT: Penn State; Henderson Bridge Replacement Building
Date of Prequalification Form Submission: ____ / ____ / ____

Please email, mail, or fax the completed form to George Germany at Massaro Corporation by or before 10/04/2010 to participate in bidding the packages listed below.

Attn: George Germany
Manager, Subcontractor Relations
Massaro Corporation
120 Delta Drive
Pittsburgh, PA 15238-2806
t. 412-963-2800
f. 412-967-9915
ggermany@massarocorporation.com

Criteria utilized in prequalifying subcontractors/vendors for this project:
• Safety Record (EMR < 1.0)
• Financial means to complete project
• Similar project experience
• BIM capabilities (Structural Steel, Fire Prot, Plumbing, HVAC, Electrical)
• LEED Project Experience

Bid Package (w/ Approx. Budgets) – Please Check the Package(s) you intend to submit a bid:

___ 1 Hazardous Building Materials Abatement 800-290.HA1.1 ($30k)
___ 2 Building Demolition 800-290.BD2.1 ($115k)
___ 3 General Trades 800-290.GC3.1 ($25.4m)
___ 4 Fire Protection 800-290.5 ($360k)
___ 5 Plumbing 800-290.3 ($730k)
___ 6 HVAC 800-290.2 ($4.1m)
___ 7 Electric 800-290.EL1.4 ($2.9m)
___ 8 Telecommunications 800-290.TL2.4 (Low Voltage Systems ($1.25m)
___ 9 Landscaping 800-290.LA4.1 ($425k)

FIRM NAME: ___________________________________________________________________
Address: _____________________________________________________________
City: __________________________________ State: ____________ Zip: ___________
Phone: (_______)____________________ Fax: (_________)________________________
Bidding Contact Name: ____________________________ Email:____________________________
Company Web Site ___________________________________ State: _______________________

BONDING:
Surety Company: ____________________________________________________________
Agent Company: _____________________________________________________________
Agent Contact: __________________________________ Phone (___)
Your Bonding Capacity: Single $ ____________ Aggregate $__________________________
Bonding Capacity Available: $ _______________________________________________

*Include a letter from your surety outlining your bonding capacity in a format similar to the attached
INSURANCE:

Insurance Company: ______________________________________________________________
Agent Company: _________________________________________________________________
Agent Contact: ___________________________________________________________________

*Attach sample certificate of insurance evidencing all lines of insurance currently in place.

SAFETY:

YEAR ⇒ Workers’ Compensation Experience Modification Rate for last three years.
NOTE: If EMR Average for last three years in over 1.0, you must submit an OSHA 200 log for each year with this response.

Have you had any OSHA fines within the last three years? YES NO
Have you had any jobsite fatalities within the last three years? YES NO

If you have answered YES to either of the above two questions, you MUST submit on separate sheet the details describing the circumstances surrounding each incident.

GENERAL:

Years in business under present name (minimum of three years required): ______________
Years performing work specialty (minimum of three years required): _____________________
Current Cost to Complete Backlog: $____________________
Annual Revenue Last Year: $____________________
Average Annual Revenue Over Last Three Years: $____________________

What trades of work do you usually perform with your own forces: __________________________________

% of work performed by own forces: ____________%

Will your project foreman for this project have OSHA 30 hour training? __________

Are you a certified WBE, MBE, or DBE? __________ If yes, which? _____________________________
Certified thru (DGS, PADOT, etc.)? _______________ Please also attach a certificate.

Are you currently or have you worked with Massaro Corporation in the Past?
List Project Names

______________________ ______________________
______________________ ______________________
______________________ ______________________

Total number of permanent staff/present staff employed includes the following # of people:

<table>
<thead>
<tr>
<th>Management</th>
<th># __________</th>
<th>Superintendents</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineers/ Arch.</td>
<td># __________</td>
<td>Foremen</td>
<td># __________</td>
</tr>
<tr>
<td>Draftsmen</td>
<td># __________</td>
<td>Skilled Craftsman</td>
<td># __________</td>
</tr>
<tr>
<td>Project Managers</td>
<td># __________</td>
<td>Unskilled Labor</td>
<td># __________</td>
</tr>
<tr>
<td>Project Engineers</td>
<td># __________</td>
<td>BIM Modelers</td>
<td># __________</td>
</tr>
<tr>
<td>Estimators</td>
<td># __________</td>
<td>Other</td>
<td># __________</td>
</tr>
<tr>
<td>Other</td>
<td># __________</td>
<td># __________</td>
<td></td>
</tr>
</tbody>
</table>
**BIM (Building Information Modeling)**

Have you worked on a project utilizing BIM? 

If not, are you capable of utilizing BIM on a project? 

If so, list projects and contract value.

How are you utilizing BIM on these projects?

What software do you intend to use?

Will the model be maintained by your own forces?

Are you or would you have an issue sharing your BIM model?

**LEED Project Experience**

Have you worked on LEED Projects? How many?

Do you have LEED Certified Professionals?

Will you dedicate a LEED Professional this project?

Please list LEED Certified projects your firm has completed including contract values:

**LIST THREE TRADE REFERENCES** (or attach a list of trade references with this response)

**Reference 1:**
Company: 
Contact: Phone: (___)

**Reference 2:**
Company: 
Contact: Phone: (___)

**Reference 3:**
Company: 
Contact: Phone (___)

**LIST THREE OWNERS, GENERAL CONTRACTORS, OR CONSTRUCTION MANAGERS YOU HAVE WORKED FOR WITHIN THE PAST TWO YEARS:**

**Reference 1:**
Company: 
Contact: Phone: (___)
Project:

**Reference 2:**
Company: 
Contact: Phone (___)
Project:

**Reference 3:**
Company: 
Contact: Phone (___)
Project:
LIST THREE MOST SIGNIFICANT PROJECTS PRESENTLY UNDER CONSTRUCTION:

Project 1:
- Project: ____________________________________________
- Location: ____________________________________________
- Architect, GC, CM or Owner: ____________________________
- Contact: ____________________________________________ Phone: (_____)
- Contract Amount: $___________________________ Completion Date: ___/___/___

Project 2:
- Project: ____________________________________________
- Location: ____________________________________________
- Architect, GC, CM or Owner: ____________________________
- Contact: ____________________________________________ Phone: (_____)
- Contract Amount: $___________________________ Completion Date: ___/___/___

Project 3:
- Project: ____________________________________________
- Location: ____________________________________________
- Architect, GC, CM or Owner: ____________________________
- Contact: ____________________________________________ Phone: (_____)
- Contract Amount: $___________________________ Completion Date: ___/___/___

LIST THREE PROJECTS OF SIMILAR SIZE COMPLETED IN THE LAST 5 YEARS (not including projects listed above):

Project 1:
- Project: ____________________________________________
- Location: ____________________________________________
- Architect, GC, CM or Owner: ____________________________
- Contact: ____________________________________________ Phone: (_____)
- Contract Amount: $___________________________ Completion Date: ___/___/___

Project 2:
- Project: ____________________________________________
- Location: ____________________________________________
- Architect, GC, CM or Owner: ____________________________
- Contact: ____________________________________________ Phone: (_____)
- Contract Amount: $___________________________ Completion Date: ___/___/___

Project 3:
- Project: ____________________________________________
- Location: ____________________________________________
- Architect, GC, CM or Owner: ____________________________
- Contact: ____________________________________________ Phone: (_____)
- Contract Amount: $___________________________ Completion Date: ___/___/___
BANK REFERENCES, CREDIT REFERENCES:

Bank Name: ____________________________________________
Contact: ____________________________________________ Phone: ( ____ ) ____________________________

Has firm: Failed to complete a contract YES NO
 Been involved in bankruptcy or reorganization YES NO
 Pending judgment claims or suits against firm YES NO
(If answer to proceeding is yes, submit details on separate sheet.)

FINANCIAL STATEMENT:
Please submit a financial statement for this company. (A current Certified Financial Statement prepared by an independent third party is preferable.) The Financial Statement should contain reasonably current data and reflect the general current financial condition of the firm.

Date of Statement on balance sheets: ____/____/____

Firm preparing statements: ____________________________________________

I hereby certify that the above information is true and complete to the best of my knowledge.

Signature: __________________________________________________________
(Officer of the Firm)

Name: _____________________________________________________________
Title: _______________________________________________________________
Date: _______________________________________________________________

Type of Firm
Corporation
Partnership
Sole Proprietor
Limited Liability Co.

END OF PREQUALIFICATION FORM
PART 1 - GENERAL

1.1 SUMMARY

A. The work of this Section shall be performed and coordinated between the University Arborist, PSU Facilities personnel and the General Contractor. All other work by the Contractor must be coordinated with this Section when working in areas near Tree Protection fencing.

B. Section specifies the procedures and sequencing for Tree Protection, and Preservation between the Contractor and University Arborist.
   1. Site visits by the University Arborist.
   2. Installation of Tree Protection measures by the Contractor.
   3. Tree root pruning prior to construction activities by the University Arborist.
   4. Installation of tree protection, air spading and aeration mats to minimize root compaction by the University Arborist.
   5. General tree maintenance during construction by the University Arborist.
   6. Specific Arboriculture Actions by the University Arborist.

C. Related Sections include the following:
   1. Division 2 Section “Unit Paving”, for installation of brick paving.
   2. Division 2 Section “Concrete”, for installation of the paver base.

1.2 REFERENCES

A. Publications listed herein are part of this specification to extent referenced.

B. Standard Practices for Trees, Shrubs, and Other Woody Plant Maintenance, Cabling, Guying, Lightning Protection, ANSI A300

C. ANSI Z133 Tree Care Operations - Safety Standards

1.3 DEFINITIONS

A. Diameter: Is defined as diameter at breast height (DBH) that is the average tree diameter at 4.5 feet from the ground on the uphill side of the tree.

B. Caliper: Is defined as the diameter of the trunk at 6” above the soil for trees up to 6” in caliper and diameter at 12” above the soil for trees up to 12” caliper.

C. Critical Root Zone (CRZ): Is defined as that area of roots within a circle measured by a radius of 1.5 feet from the trunk for every inch of diameter of the trunk, or as depicted on the Tree Protection Plan.

D. Tree Preservation Area: Is defined as all areas outside limits of construction, which contain trees and all areas within the limits of construction that is designated on the plans and/or in the field by fencing and signage.
E. Limit of Disturbance: Is defined, as areas of excavation, or fills for site grading, walkways and/or utility easements and alignments required for the construction of the work, near or within the tree preservation areas.

F. Soil Protection Zones: Are defined as soil areas that shall not be turned, excavated, compacted, or altered in anyway.

G. Damage: Is defined as any unauthorized encroachment into the tree preservation areas and soils protection zones beyond the limits of work as indicated on the civil drawings whether fencing is present or not and at any time during the construction process including the paver installation and fine grading operations.

H. University Arborist is the Pennsylvania State University's approved representative to review and monitor the implementation of the tree protection, impact reduction and arboricultural action measures. University Arborist or their personnel shall perform the work of the tree protection measures and remediation measures. University Arborist shall monitor as needed and report violations of preservation or changes in the implementation of the specifications, when necessary.

1.4 SUBMITTALS

A. Provide data on the following operations for proper coordination of the tree protection measures, as well as any last minute alterations to the site utility work that may adversely impact existing mature trees.
   1. Site lighting, and electrical conduit runs; provide shop drawings to the University Arborist for any runs that may impact tree preservation.
   2. Final Paving Layout and elevation cut sheets.
   3. Any change to the designated concrete washout areas.

1.5 QUALITY ASSURANCE

A. Preconstruction Conference: University Arborist shall conduct a reinstallation conference at the project site to comply with the requirements in Division 1 Section “Project Meetings”.
   1. Before Contractor commences tree-fencing work, he shall meet with the University Arborist, consultants and other interested entities.
   2. Review the scope, methods and procedures for tree protection work as well as the project specifications to reduce or mitigate impacts to the existing trees.
   3. Notify participants at least three working days prior to convening the conference.
   4. Record discussions and agreements, and furnish a copy to each participant.

1.6 PROJECT CONDITIONS

A. Construction Activity: No construction, including staging and stockpile shall start until all the tree protection measures and procedures are completed as designated on the Tree Protection Plan, and approved by the University Arborist.

B. Bring conflicts between the Drawings and site conditions to the University Representative for clarification prior to commencing tree protection work.

C. Diameters of all trees to be preserved have been recorded on the Tree Protection Plan, prior to construction and shall be the basis for assessment of replacement trees damaged by construction activities.
1.7 PROCEDURES FOR TREE PRESERVATION

A. Review of Tree Protection Plan and Limits of Disturbance (LOD).
   1. The Contractor shall meet with the Architect and/or University’s Representative, University Arborist, in the field to review the location of trees to be preserved, the limits of Construction, the sequence for installation of tree protection and the conversion of the Pedestrian/ Bike path into the Construction Access road.
   2. Any potential conflicts between construction plans and preservation requirements shall be discussed and/or brought to the University Representative at that time.

B. Projected Sequence of Tree Preservation Measures by University Arborist prior to Contractor activities:
   1. Tree Identification
   2. Air Spading
   3. Root Pruning
   4. Root Mulching
   5. Installation of Root Protection Mats and Filter Fabrics
   6. Crown Pruning and Trunk and Major Limb Protection Measures

C. Projected Sequence of Tree Preservation Measures by Contractor after Arborist but prior to construction activities:
   1. Installation of Tree Protection Fencing
   2. Installation of Silt Fencing
   3. Installation of Aggregate base for Construction Access Road.

D. Fencing Adjustments required during Construction.
   1. University Arborist must approve and closely monitor any work within the Tree Preservation areas. The University Arborist must approve any fence removal or relocation required by the work and will supervise the reinstallation. Any conflicts or compromises that will affect the preserved tree long term shall be reported to the Architect and University Representative. Written approval is required prior to operation of any heavy equipment in CRZ area. Any opening of tree preservation areas during construction for foot or equipment traffic or any construction activities shall be accompanied by soil compaction reduction measures such as min. 6” wood chips as specified in Section 2.7 or geo-textile matting with plywood. Protect all woody parts of trees from abrasion when fence is down.
   2. Any damage to trees to be preserved caused by the activities of the contractor or his subcontractors shall be subject to review by the University Arborist. Reasonable remediation activities will be as designated in Section 3.12 and 3.13.

1.8 SITE MONITORING

A. The University Arborist may conduct daily site visits to insure contractor compliance with tree preservation measures.

B. Contact the University Arborist for any questions or concerns regarding Tree Preservations measures.
PART 2 - PRODUCTS

2.1 TREE PROTECTION FENCING (To be provided by the Contractor)

A. Construction Staging Fencing:
   1. 6 ft height chain link fencing, with welded wire: 3x3" maximum mesh, 14 gauge; with, high visibility, heavy duty ('Arctic'), plastic flagging @ 5' O.C., in 2' lengths.

B. Silt Fencing:
   1. As required on the Civil Engineering drawings and the City of Baltimore approved Erosion Control Drawings.

C. Limit of Disturbance, Walkway and Utility Limits:
   1. 36" Blaze Orange Plastic Safety Fencing as a minimum, and as required by JHU field representative for pedestrian safety.
   2. Posts: Steel T- Bar or heavy duty U-bar fence post, 5' Ht. @ 10’ O.C. or as required.

D. Tree Preservation Fencing
   1. 6’ Chain Link with hollow steel posts anchored 2’ into the ground. Posts shall be a maximum of 10’ apart.

2.2 UNIVERSITY SUPPLIED ITEMS (As Required)

A. Root Protection and Aeration Mats
B. Root-Bio-Stimulant
C. Vertical Mulching
D. Control Agents
E. Integrated Pest Management (IPM)
F. Mulch or Wood chips
G. Cables And Hardware

PART 3 - EXECUTION

3.1 AIR SPADE TRENCHING (To be Coordinated by the University)

A. University Arborist personnel shall excavate trees within the CRZ impacted by the Construction Access Road by utilizing Air Spade Trenching techniques as required protect and prune roots.

B. Care shall be exercised so as not to damage the exterior membrane of existing exposed tree roots and root flares.

C. Air trench no greater an area than that required to install the Access Road or as required to complete work and minimally expose tree root systems. Arborist shall determine which roots shall be preserved and which roots can be cut.
D. Grades within CRZ shall remain, as close to existing as possible in order to minimize gravel fill over roots or root removal of structural roots. Where soil must be brought to grade over existing tree roots then Arborist shall install soil aeration matting over roots prior to backfill operations where the change exceeds 2". Do not fill within 18" of trunk.

3.2 **ROOT PRUNING** (To be Coordinated with the University)

A. Root pruning shall be performed in conjunction with fencing when excavation will occur and where deemed necessary by the University Arborist.

B. Root pruning shall be performed wherever grades will be lowered within the Critical Root Zone of a significant tree to be preserved as specified by the University Arborist.

C. Roots over 2" in diameter shall have a clean cut made on the surface of the root, which is still attached to the tree. This cut shall be made with a handsaw or chain saw as soon as larger root is severed.

D. Where backfilling around tree roots is delayed Arborist may protect exposed roots with moist burlap and plastic tarps. Do not remove to allow roots to dry out during air trenching operations.

3.3 **INSTALLATION OF ROOT PROTECTION & AERATION MATTING** (To be Coordinated with the University)

A. University Arborist will place protection mats as required to protect existing roots for construction impacts.

B. In other areas Soil Separation Fabric may be used to protect existing grades from compaction by aggregates.

3.4 **PRUNING** (To be Coordinated with the University)

A. Pruning will be undertaken by the University Arborist on to remove any hazard branches, crossing branches, dying or diseased branches, or the formative pruning of branches.

B. Crown Cleaning, Thinning, Raising or Reduction will be performed by the University Arborist.
   1. Consideration should also be given to the type, extent, and nature of the pruning required and the ability of the tree species to sustain this type of pruning.

3.5 **MULCHING** (To be Coordinated with the University)

A. Arborist shall mulch designated trees with root zones to be impacted by construction within the CRZ by construction activities.

B. Arborist shall determine depth of mulch layers in tree preservation fencing and within CRZ. Mulch shall be kept at least six inches from the trunk of all trees. The mulch ring shall have a minimum radius of 6 inches per foot of trunk diameter, or six feet, whichever is greater. Root prune lines for grading or excavations shall have mulch applied as above, up to the root prune line, and length of the applicable Critical Root Zone.
3.6 TREE PROTECTION FENCING (To be performed by the Contractor)

A. Contractor shall install tree protection fencing in locations shown on the drawings or as adjusted by the University Arborist. Installation to be coordinated with Contractor after root pruning, mulching and mat protection is installed. Maintain fencing in good repair at original locations throughout construction period, or until site work, including all soil installation or preparation not within the tree protection areas is complete. If work is required to be done with the tree protection area it shall be done by written approval.

B. Install the Orange Blaze fencing to designate the Limits of Construction (LOC) outside the tree preservation fencing to limit impacts to the CRZ of existing trees. Fencing shall be maintained in good repair until no longer required to contain the contractor's construction activity within the CRZ's.

C. Any issues, which arise during construction that may require relocation of protective fencing, will require written approval from University Arborist, or Architect.

D. If fences should become damaged, fall down or are no longer functional, the Contractor shall repair or replace the fence the day it is damaged and shall assume liability for any damages that may occur to trees or vegetation within the protected areas and if Contractor fails to repair fence, they will be liable for all costs incurred by the University for having fence repaired.

E. All construction activity within the areas fenced off around the trees shall be prohibited. This shall include the following activities:
   1. Parking or driving of equipment, machinery or vehicles of any type.
   2. Foot traffic.
   3. Storage of any construction materials, equipment, stockpiling, excavation or fill, soil, gravel, etc.
   4. Dumping of any chemicals, (i.e. paint thinner from cleaning brushes), wash-out materials from cleaning equipment, concrete or mortar remainder, trash, garbage, or debris of any kind
   5. Trenching or grading within the critical root zones of protected trees for any purpose without notifying University Arborist within 5 days in advance of operation in writing. This includes but is not limited to the following: silt fence, sediment erosion control, utilities, site lighting, pavement installations, drainage etc.

3.7 SILT PREVENTION (To be performed by the Contractor)

A. The locations of silt fencing shall be as indicated on the Civil Engineers Erosion Control plans. Additional silt fencing shall be installed as necessary to prevent silt from entering Tree Protection and Preservation areas.

B. Silt and stone dust shall not be allowed to collect in preservation areas. Silt accumulating in preservation areas shall constitute damage and will require remedial activity for its removal. All silt will be removed from preservation areas within 48 hours of siltation. The methods and procedures for silt removal within tree preservation areas will be approved and monitored by the University Arborist. If silt is not removed within the 48 hours specified, Contractor will be liable for all costs incurred by University for having it removed. Additional remedial activity such as aeration, fertilization, and mulching may also be required.

C. Alterations to the approved grading plans may be required due to unforeseen surface drainage problems or modifications to site plans. Any changes to the grading plan, which may result in the accumulation of silt within Tree Protection or Preservation Areas, shall require the Contractor to install additional silt fencing to prevent siltation of these areas.
D. Silt fencing and other devices shall not be removed until site is stabilized and potential for siltation of preservation areas is controlled. Any silt accumulating following the removal of silt fencing shall be removed within 48 hours.

3.8 GENERAL EXCAVATION PROCEDURES WITH CRITICAL ROOT ZONES (CRZ)

A. Protection of existing trees adjacent to excavation and fills, involves the following operations; removal of excavated soils or pavements, root pruning, placement of fills, and protection of root systems from construction equipment tires and tracks.

B. Demolition and removal existing pavements and curbs within the CRZ’S shall be done in a manner to minimize damage and further compaction to existing tree roots below pavements. Use means and methods that effectively pulls or lifts these materials away from the tree trunks and deposited in pieces for hauling outside the CRZ.

C. Excavated fill dirt should be placed away from CRZ. If no room exists due to structures or adjacent trees, fill dirt may be placed on Root Protection Matting, comprised of plywood, geotextile, or steel mat or other suitable "deck" to contain the fill and minimize compaction and mechanical damage to surface roots. Other means of protecting roots from damage due to excavated fill can be approved by the (University Arborist). Planking or other decking may be necessary when backhoes or tracked equipment is operating within the CRZ. Turning and rutting within this area shall be avoided. University Arborist will identify trees requiring additional protection prior to excavation.

D. Root pruning should take place prior to excavation with equipment as designated on the Tree Preservation Plan by the designated Contract Arborist as noted above. Root Pruning may be necessary after demolition but prior to construction of site walls. Contractor shall contact University Arborist if roots are encountered during construction of site walls and paving outside of tree preservation areas.

E. Equipment damage that scars trunks and major limbs should be avoided. Protecting a trunk from mechanical damage with plywood, geo-textile, fencing as may be necessary when work is very close. Over-hanging limbs shall be pulled and tied out of the way for small trees and branches. The designated University Arborist shall prune larger low hanging limbs if under 4” c. or work out additional protection measures. Contractor shall not prune trees under any condition. These situations can be reviewed in a preconstruction walk through or during layout of work. These protection measures shall be the responsibility of the designated University Arborist.

3.9 FERTILIZATION AND ROOT BIOSTIMULATION

A. All designated significant trees shall receive root stimulation as recommended by the University Arborist.

B. Refer to label instructions for rates of application for the bio-stimulant.

3.10 INTEGRATED PEST MANAGEMENT

A. University Arborist shall provide an IPM technician and equipment to make necessary treatments. University Arborist shall also report any other issues observed on site that may affect the survival of trees.
B. Watering shall be included in IPM program. Water shall be applied to key trees during site inspection visits whenever soil moisture is below 40% of field capacity.

3.11 OTHER REMEDIAL ACTIVITIES

A. University Arborist will provide other Arboricultural services as necessary to respond to damage by construction activities. These services may include any of the above, as well as vertical mulching/aeration, silt removal, fence repair, pruning, removals, soil replacement, etc.

B. Trees with weak structural characteristics shall be cabled using appropriate size hardware.

C. Reports of damage and recommended remediation shall be provided to the University Representative for determination of Contractor's liability.

3.12 TREE REPAIR AND REPLACEMENT

A. Contractor to promptly repair trees damaged by construction operations with 24 hours. Remove and replace dead and damaged trees that the determined to be incapable of restoring to a normal growth pattern.

B. The University Arborist may enlist an ASCA registered Consulting Arborist to evaluate the tree in question and recommend compensation if there is a conflict.

C. Compensation for Damages:
   1. Minor Damage: The University Arborist will assess the Contractor a penalty fee of $75 per square inch of damaged areas on tree trunks and major limbs, not to exceed the value of the tree, for injuries caused by the Contractor.
   2. Major Damage: If the University Arborist or ASCA registered Consulting Arborist determine that damages to tree(s) caused by the contractor will either cause the eventual death of a tree or have the affected tree's normal growth pattern to the point that it cannot be restored, the University will assess the Contractor the value of the tree as determined by the Consulting Arborist.
   3. Tree Value: The value of the tree may be established by one of the following methods, depending on the tree trunk caliper.
      a. Tree Caliper less than 6 inches: Value will be based on replacement cost.
      b. Tree Caliper 6 inches and greater: Value will be determined ISA Valuation Method, 2000
   4. For trees less than 6 inches in caliper, provide new trees of the same size and species as those being replaced; plant and maintain for a period of One Year from the date of planting.
   5. For trees larger than 6 inches in caliper, provide as many new trees as required to match the value of the assessed damages, install trees at a minimum 6 inch in caliper size as measured according to ANLA standards, and of a species selected by the Architect and/ or University. Plant and maintain for a period of One Year from the date of planting.

END OF SECTION - 01 5639
SECTION 01 73 29 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes procedural requirements for cutting and patching.

B. Related Sections include the following:
   1. Division 01 Section "Selective Structure Demolition" for demolition of selected portions of the building.
   2. Divisions 02 through 49 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.
   3. Division 07 Section "Penetration Firestopping" for patching fire-rated construction.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.4 SUBMITTALS

A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
   1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
   2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
   3. Products: List products to be used and firms or entities that will perform the Work.
   4. Dates: Indicate when cutting and patching will be performed.
   5. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
   6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
   7. Architect's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

1.5 QUALITY ASSURANCE

A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that result in increased maintenance or decreased operational life or safety. Operating elements include the following:
1. Primary operational systems and equipment.
2. Air or smoke barriers.
3. Fire-suppression systems.
4. Mechanical systems piping and ducts.
5. Control systems.
6. Communication systems.
7. Conveying systems.
8. Electrical wiring systems.

C. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity that results in reducing their capacity to perform as intended, or that result in increased maintenance or decreased operational life or safety. Miscellaneous elements include the following:
1. Water, moisture, or vapor barriers.
2. Membranes and flashings.
3. Exterior curtain-wall construction.
4. Equipment supports.
5. Piping, ductwork, vessels, and equipment.

D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

1.6 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

3.3 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

   1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

   1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.

   2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.

   3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.

   4. Excavating and Backfilling: Comply with requirements in applicable Division 31 Sections where required by cutting and patching operations.

   5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.

   6. Proceed with patching after construction operations requiring cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.

   1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

   2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

      a. Clean piping, conduit, and similar features before applying paint or other finishing materials.

      b. Restore damaged pipe covering to its original condition.

   3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

      a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

   4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

D. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

3.4 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
   1. Separate tempered glass waste for use as aggregate of nonstructural fill.

C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 01 73 29
SECTION 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Salvaging nonhazardous demolition and construction waste.
2. Recycling nonhazardous demolition and construction waste.
3. Disposing of nonhazardous demolition and construction waste.

B. Related Requirements:

1. Division 02 Section "Structure Demolition" for disposition of waste resulting from demolition of buildings, structures, and site improvements.
2. Division 02 Section "Selective Structure Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements.
3. Division 04 Section "Unit Masonry" for disposal requirements for masonry waste.
4. Division 04 Section "Stone Masonry" for disposal requirements for excess stone and stone waste.
5. Division 31 Sections for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.
1.4 PERFORMANCE REQUIREMENTS

A. General: Achieve end-of-Project rates for salvage/recycling of 75 percent by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:

1. Demolition Waste:
   a. Asphalt paving.
   b. Concrete.
   c. Concrete reinforcing steel.
   d. Brick.
   e. Concrete masonry units.
   f. Wood studs.
   g. Wood joists.
   h. Plywood and oriented strand board.
   i. Wood paneling.
   j. Wood trim.
   k. Structural and miscellaneous steel.
   l. Rough hardware.
   m. Roofing.
   n. Insulation.
   o. Doors and frames.
   p. Door hardware.
   q. Windows.
   r. Glazing.
   s. Metal studs.
   t. Gypsum board.
   u. Acoustical tile and panels.
   v. Carpet.
   w. Carpet pad.
   x. Demountable partitions.
   y. Equipment.
   z. Cabinets.
   aa. Plumbing fixtures.
   bb. Piping.
   cc. Supports and hangers.
   dd. Valves.
   ee. Sprinklers.
   ff. Mechanical equipment.
   gg. Refrigerants.
   hh. Electrical conduit.
   ii. Copper wiring.
   jj. Lighting fixtures.
   kk. Lamps.
   ll. Ballasts.
   mm. Electrical devices.
   nn. Switchgear and panelboards.
   oo. Transformers.

2. Construction Waste:
   a. Masonry and CMU.
   b. Lumber.
   c. Wood sheet materials.
d. Wood trim.
e. Metals.
f. Roofing.
g. Insulation.
h. Carpet and pad.
i. Gypsum board.
j. Piping.
k. Electrical conduit.
l. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:
   1) Paper.
   2) Cardboard.
   3) Boxes.
   4) Plastic sheet and film.
   5) Polystyrene packaging.
   7) Plastic pails.

m. Waste from On-Site Personnel:
   1) Paper.
   2) Cardboard.
   3) Plastic bottles and containers.
   4) Aluminum cans.
   5) Tin cans.
   6) Newspaper.
   7) Glass bottles and containers.

1.5 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 7 days of date established for the Notice to Proceed.

1.6 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use separate forms for construction waste and demolition waste. Form format shall be as acceptable to the Owner and Architect to fully document on-site waste management activities. Include the following information:
   1. Material category.
   2. Generation point of waste.
   3. Total quantity of waste in tons.
   4. Quantity of waste salvaged, both estimated and actual in tons.
   5. Quantity of waste recycled, both estimated and actual in tons.
   6. Total quantity of waste recovered (salvaged plus recycled) in tons.
   7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

G. LEED Submittal: LEED letter template for Credit MR 2.1 and Credit MR 2.2, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.

H. Qualification Data: For waste management coordinator and refrigerant recovery technician.

I. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.7 QUALITY ASSURANCE

A. Waste Management Coordinator Qualifications: Experienced firm, with a record of successful waste management coordination of projects with similar requirements, that employs a LEED-Accredited Professional, certified by the USGBC, as waste management coordinator. Waste management coordinator may also serve as LEED coordinator.

B. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

C. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

D. Waste Management Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of waste management coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
5. Review waste management requirements for each trade.

1.8 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
B. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing and construction waste generated by the Work. Use separate forms for construction waste and demolition waste. Form format shall be as acceptable to the Owner and Architect to fully document on-site waste management activities. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Use separate forms for construction waste and demolition waste. Form format shall be as acceptable to the Owner and Architect to fully document on-site waste management activities. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
3. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
4. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
5. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Use separate forms for construction waste and demolition waste. Form format shall be as acceptable to the Owner and Architect to fully document on-site waste management activities. Include the following:

1. Total quantity of waste.
2. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
3. Total cost of disposal (with no waste management).
4. Revenue from salvaged materials.
5. Revenue from recycled materials.
7. Savings in hauling and tipping fees that are avoided.
8. Handling and transportation costs. Include cost of collection containers for each type of waste.
9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

1. Comply with operation, termination, and removal requirements in Division 01 Section "Temporary Facilities and Controls."
B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.

C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.

1. Distribute waste management plan to everyone concerned within three days of submittal return.
2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
2. Comply with Division 01 Section "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

E. Waste Management in existing Campus Areas: Hauling equipment and other materials shall be of sizes that clear surfaces within buildings, landscaped spaces, areas, rooms, and openings, by 12 inches or more.

3.2 SALVAGING DEMOLITION WASTE

A. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
3. Store items in a secure area until installation.
4. Protect items from damage during transport and storage.
5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

B. Salvaged Items for Sale: Not permitted.

C. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

D. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

E. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.

F. Plumbing Fixtures: Separate by type and size.
G. Lighting Fixtures: Separate lamps by type and protect from breakage.

H. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Recycling Receivers and Processors: Locate available recycling receivers and processors within the region of the project:

C. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall be documented by the Construction Manager for the Project Records and shared equally by Owner and Contractor.

D. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

E. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

   1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
      a. Inspect containers and bins for contamination and remove contaminated materials if found.
      b. Refer to “OWNER'S REQUIREMENTS” in Section 02 41 16 Structure Demolition and Section 02 41 19 Selective Structure Demolition for proper disposal instructions for demolition of painted materials.

   2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
   4. Store components off the ground and protect from the weather.
   5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor.

3.4 RECYCLING DEMOLITION WASTE

A. Asphalt Paving: Grind asphalt to maximum 1-1/2-inch size.

   1. Crush asphaltic concrete paving and screen to comply with requirements in Division 31 Sections for use as general fill, if permitted.

B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.

C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.

   1. Pulverize concrete to maximum 1-1/2-inch size.
2. Crush concrete and screen to comply with requirements in Division 31 Sections for use as satisfactory soil for fill or subbase, if permitted.

D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
   1. Pulverize masonry to maximum 1-1/2-inch size.
      a. Crush masonry and screen to comply with requirements in Division 31 Sections for use as general fill, satisfactory soil for fill or subbase, if permitted.
      b. Crush masonry and screen to comply with requirements in Division 32 Section "Plants" for use as mineral mulch, if permitted.
   2. Clean and stack undamaged, whole masonry units on wood pallets.

E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

F. Metals: Separate metals by type.
   1. Structural Steel: Stack members according to size, type of member, and length.
   2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

G. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.

H. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.

I. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.

J. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.

K. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
   1. Store clean, dry carpet and pad in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

L. Carpet Tile: Remove debris, trash, and adhesive.
   1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

M. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.

N. Conduit: Reduce conduit to straight lengths and store by type and size.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:
   1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
   a. Comply with requirements in Division 32 Section "Plants." for use of clean sawdust as organic mulch.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.
   a. Comply with requirements in Division 32 Section "Plants." for use of clean ground gypsum board as inorganic soil amendment, if permitted.

3.6 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Disposal: Remove waste materials from Owner's property and legally dispose of them.

END OF SECTION 01 74 19
SECTION 01 81 13 - SUSTAINABLE DESIGN REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements and procedures for compliance with certain USGBC LEED prerequisites and credits needed for Project to obtain LEED-Certified certification based on LEED-NC, Version 2.2.

1. Other LEED prerequisites and credits needed to obtain LEED certification depend on material selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.

2. Additional LEED prerequisites and credits needed to obtain the indicated LEED certification depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.

3. A copy of the LEED Project checklist is attached at the end of this Section for general information and delineation of responsibilities related to LEED certification requirements.

B. Related Sections:

1. Divisions 01 through 33 Sections for LEED requirements specific to the work of each of these Sections. Requirements may or may not include reference to LEED.

1.3 DEFINITIONS

A. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-FSC-accredited certification body.

B. LEED: Leadership in Energy & Environmental Design.

C. Rapidly Renewable Materials: Materials made from plants that are typically harvested within a 10-year or shorter cycle. Rapidly renewable materials include products made from bamboo, cotton, flax, jute, straw, sunflower seed hulls, vegetable oils, or wool.

D. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

E. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.
1. "Post-consumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.

2. "Pre-consumer" material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

1.4 SUBMITTALS

A. General: Submit additional LEED submittals required by other Specification Sections.

B. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

C. Project Materials Cost Data: Provide statement indicating total cost for materials used for Project. Costs exclude labor, overhead, and profit. Include breakout of costs for the following categories of items:

1. Fixed Furniture.
2. Plumbing.
3. Mechanical.
4. Electrical.
5. Specialty items such as elevators and equipment.

D. LEED Action Plans: Provide preliminary submittals within days of date established for the Notice to Proceed indicating how the following requirements will be met:

1. Credit MR 2.1 and Credit MR 2.2: Waste management plan complying with Division 01 Section "Construction Waste Management and Disposal."
2. Credit MR 4.1 and Credit MR 4.2: List of proposed materials with recycled content. Indicate cost, post-consumer recycled content, and pre-consumer recycled content for each product having recycled content.
3. Credit MR 5.1, Credit MR 5.2 and Credit ID 1.1: List of proposed regional materials. Identify each regional material, including its source, cost, and the fraction by weight that is considered regional.
4. Credit MR 7 and Credit ID 1.2: List of proposed certified wood products. Indicate each product containing certified wood, including its source and cost of certified wood products.

E. LEED Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with LEED action plans for the following:

1. Credit MR 2.1 and Credit MR 2.2: Waste reduction progress reports complying with Division 01 Section "Construction Waste Management and Disposal."
2. Credit MR 4.1 and Credit MR 4.2: Recycled content.
3. Credit MR 5.1, Credit MR 5.2 and ID 1.1: Regional materials.
4. Credit MR 7 and Credit ID 1.2: Certified wood products.

F. LEED Documentation Submittals:

1. Credit MR 2.1 and Credit MR 2.2: Comply with Division 01 Section "Construction Waste Management and Disposal."
2. Credit MR 4.1 and Credit MR 4.2: Product data and certification letter indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.

3. Credit MR 5.1, Credit 5.2 and Credit ID 1.1: Product data for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

4. Credit MR 7 and Credit ID 1.2: Product data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.

5. Credit EQ 3.1:
   a. Construction indoor-air-quality management plan.
   b. Product data for temporary filtration media.
   c. Product data for filtration media used during occupancy.
   d. Construction Documentation: Six photographs at three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor-air-quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.

6. Credit EQ 3.2:
   a. Signed statement describing the building air flush-out procedures including the dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
   b. Product data for filtration media used during flush-out and during occupancy.
   c. Report from testing and inspecting agency indicating results of indoor-air-quality testing and documentation showing compliance with indoor-air-quality testing procedures and requirements.

7. Credit EQ 4.1: Product data for adhesives and sealants used inside the weatherproofing system indicating VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D.

8. Credit EQ 4.2: Product data for paints and coatings used inside the weatherproofing system indicating VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D.

9. Credit EQ 4.3: Product data for each type of carpet verifying compliance with the requirements of the Carpet and Rug Institute Green Label program, and product data for each type of adhesive verifying compliance with the requirements of Credit EQ 4.1: VOC limit of 50 g/L.

10. Credit EQ 4.4: Product data for products containing composite wood or agrifiber products or wood glues indicating that they do not contain urea-formaldehyde resin.

1.5 QUALITY ASSURANCE

A. LEED Coordinator: Engage an experienced LEED-Accredited Professional to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator.

PART 2 - PRODUCTS

2.1 RECYCLED CONTENT OF MATERIALS

A. Credit MR 4.1 and Credit MR 4.2: Provide building materials with recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content constitutes a minimum of 20 percent of cost of materials used for Project.
1. Cost of post-consumer recycled content of an item shall be determined by dividing weight of post-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.
2. Cost of pre-consumer recycled content of an item shall be determined by dividing weight of pre-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.
3. Do not include plumbing, mechanical and electrical components, and specialty items such as elevators and equipment in the calculation.

2.2 REGIONAL MATERIALS

A. Credit MR 5.1, Credit MR 5.2 and Credit ID 1.1: Provide a minimum of 30 percent of building materials (by cost) that are regional materials.

2.3 CERTIFIED WOOD

A. Credit MR 7 and Credit ID 1.2: Provide a minimum of 75 percent (by cost) of wood-based materials that are produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

1. Wood-based materials include, but are not limited to, the following materials when made from wood, engineered wood products, or wood-based panel products:
   a. Rough carpentry.
   b. Miscellaneous carpentry.
   c. Heavy timber construction.
   d. Wood decking.
   e. Metal-plate-connected wood trusses.
   f. Structural glued-laminated timber.
   g. Finish carpentry.
   h. Architectural woodwork.
   i. Wood paneling.
   j. Wood veneer wall covering.
   k. Wood flooring.
   l. Wood lockers.
   m. Wood cabinets.
   n. Fixed Furniture.

2.4 LOW-EMITTING MATERIALS

A. Credit EQ 4.1: For field applications that are inside the weatherproofing system, use adhesives and sealants that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D:

1. Wood Glues: 30 g/L.
2. Metal to Metal Adhesives: 30 g/L.
3. Adhesives for Porous Materials (Except Wood): 50 g/L.
4. Subfloor Adhesives: 50 g/L.
5. Plastic Foam Adhesives: 50 g/L.
6. Carpet Adhesives: 50 g/L.
7. Carpet Pad Adhesives: 50 g/L.
8. VCT and Asphalt Tile Adhesives: 50 g/L.
9. Cove Base Adhesives: 50 g/L.
10. Gypsum Board and Panel Adhesives: 50 g/L.
11. Rubber Floor Adhesives: 60 g/L.
12. Ceramic Tile Adhesives: 65 g/L.
13. Multipurpose Construction Adhesives: 70 g/L.
14. Fiberglass Adhesives: 80 g/L.
15. Contact Adhesive: 80 g/L.
16. Structural Glazing Adhesives: 100 g/L.
17. Wood Flooring Adhesive: 100 g/L.
18. Structural Wood Member Adhesive: 140 g/L.
19. Special Purpose Contact Adhesive (contact adhesive that is used to bond melamine covered board, metal, unsupported vinyl, Teflon, ultra-high molecular weight polyethylene, rubber or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
20. Top and Trim Adhesive: 250 g/L.
21. Plastic Cement Welding Compounds: 250 g/L.
22. ABS Welding Compounds: 325 g/L.
23. CPVC Welding Compounds: 490 g/L.
24. PVC Welding Compounds: 510 g/L.
25. Adhesive Primer for Plastic: 550 g/L.
26. Sheet Applied Rubber Lining Adhesive: 850 g/L.
27. Aerosol Adhesive, General Purpose Mist Spray: 65 percent by weight.
29. Special Purpose Aerosol Adhesive (All Types): 70 percent by weight.
30. Other Adhesives: 250 g/L.
31. Architectural Sealants: 250 g/L.
32. Nonmembrane Roof Sealants: 300 g/L.
33. Single-Ply Roof Membrane Sealants: 450 g/L.
34. Other Sealants: 420 g/L.
35. Sealant Primers for Nonporous Substrates: 250 g/L.
36. Sealant Primers for Porous Substrates: 775 g/L.
37. Modified Bituminous Sealant Primers: 500 g/L.
38. Other Sealant Primers: 750 g/L.

B. Credit EQ 4.2: For field applications that are inside the weatherproofing system, use paints and coatings that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D:

1. Flat Paints, Coatings, and Primers: VOC not more than 50 g/L.
2. Nonflat Paints, Coatings, and Primers: VOC not more than 150 g/L.
3. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
4. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
5. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
6. Floor Coatings: VOC not more than 100 g/L.
7. Shellacs, Clear: VOC not more than 730 g/L.
8. Shellacs, Pigmented: VOC not more than 550 g/L.
9. Stains: VOC not more than 250 g/L.
10. Dry-Fog Coatings: VOC not more than 400 g/L.
11. Zinc-Rich Industrial Maintenance Primers: VOC not more than 340 g/L.
12. Pretreatment Wash Primers: VOC not more than 420 g/L.
13. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
14. Restricted Components: Paints and coatings shall not contain any of the following:
   a. Acrolein.
   b. Acrylonitrile.
   c. Antimony.
   d. Benzene.
   e. Butyl benzyl phthalate.
   f. Cadmium.
g. Di (2-ethylhexyl) phthalate.
h. Di-n-butyl phthalate.
i. Di-n-octyl phthalate.
j. 1,2-dichlorobenzene.
k. Diethyl phthalate.
l. Dimethyl phthalate.
m. Ethylbenzene.
n. Formaldehyde.
o. Hexavalent chromium.
p. Isophorone.
q. Lead.
r. Mercury.
s. Methyl ethyl ketone.
t. Methyl isobutyl ketone.
u. Methylene chloride.
v. Naphthalene.
w. Toluene (methylbenzene).
x. 1,1,1-trichloroethane.
y. Vinyl chloride.

C. Credit EQ 4.3: Only use carpets that meet the requirements of the Carpet and Rug Institute Green Label program. Only use adhesives that meet the requirements of Credit EQ 4.1.

D. Credit EQ 4.4: Do not use composite wood or agrifiber products or adhesives that contain urea-formaldehyde resin.

PART 3 - EXECUTION

3.1 REFRIGERANT AND CLEAN-AGENT FIRE-EXTINGUISHING-AGENT REMOVAL

A. Prerequisite EA 3: Remove CFC-based refrigerants from existing HVAC&R equipment indicated to remain and replace with refrigerants that are not CFC based. Replace or adjust existing equipment to accommodate new refrigerant as described in Division 23 Sections.

B. Credit EA 4: Remove clean-agent fire-extinguishing agents that contain HCFCs or halons and replace with agent that does not contain HCFCs or halons. See Division 21 Section "Clean-Agent Fire Extinguishing Systems" for additional requirements.

3.2 CONSTRUCTION WASTE MANAGEMENT

A. Credit MR 2.1 and Credit MR 2.2: Comply with Division 01 Section "Construction Waste Management and Disposal."

3.3 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT

A. Credit EQ 3.1: Comply with SMACNA’s "SMACNA IAQ Guideline for Occupied Buildings under Construction."

1. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Division 01 Section "Temporary Facilities and Controls," install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.

2. Replace all air filters immediately prior to occupancy.
B. Credit EQ 3.2: Comply with one of the following requirements:

1. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total volume of 14000 cu. ft. of outdoor air per sq. ft. of floor area while maintaining an internal temperature of at least 60 deg F and a relative humidity no higher than 60 percent.

2. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of 3500 cu. ft. of outdoor air per sq. ft. of floor area to the space. Once a space is occupied, it shall be ventilated at a minimum rate of 0.30 cfm per sq. ft. of outside air or the design minimum outside air rate determined in EQ Prerequisite 1, whichever is greater. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of 14000 cu. ft./sq. ft. of outside air has been delivered to the space.

3. Air-Quality Testing:

   a. Conduct baseline indoor-air-quality testing, after construction ends and prior to occupancy, using testing protocols consistent with the EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air," and as additionally detailed in the USGBC's "LEED-NC: Reference Guide."

   b. Demonstrate that the contaminant maximum concentrations listed below are not exceeded:

      1) Formaldehyde:  50 ppb.
      2) Particulates (PM10):  50 micrograms/cu. m.
      3) Total Volatile Organic Compounds (TVOC):  500 micrograms/cu. m.
      4) 4-Phenylcyclohexene (4-PH):  6.5 micrograms/cu. m.
      5) Carbon Monoxide:  9 ppm and no greater than 2 ppm above outdoor levels.

   c. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from same locations as in the first test.

   d. Air-sample testing shall be conducted as follows:

      1) All measurements shall be conducted prior to occupancy but during normal occupied hours, and with building ventilation system starting at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.
      2) Building shall have all interior finishes installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Nonfixed furnishings such as workstations and partitions are encouraged, but not required, to be in place for the testing.
      3) Number of sampling locations will vary depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 sq. ft. or for each contiguous floor area, whichever is larger, and shall include areas with the least ventilation and greatest presumed source strength.
      4) Air samples shall be collected between 3 and 6 feet from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.
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1.1 WORK INCLUDED

A. Commissioning requirements common to all Sections
B. Systems and equipment ‘Start-Up’ and ‘Functional Performance Testing’
C. Validation of proper and thorough installation of systems and equipment
D. Equipment performance verification
E. Documentation of tests, procedures, and installations
F. Coordination and requirements of ‘Training Events’
G. Preparation and logistics of Systems Manual content
H. Management of record construction documentation
I. Sequencing

1.2 GENERAL DESCRIPTION

A. Commissioning (Cx) is the process of ensuring that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective and meet the Owner’s operational needs; that the installation is adequately documented; and that the Operators are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems, and establishes testing and communication protocols to advance the building systems from installation to optimized, fully-dynamic operation.

B. Commissioning Authority (CxA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.

C. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.

D. This Section and other sections of the specification details the Contractor’s responsibilities relative to the Cx process. It expands on the Cx Plan, which covers the roles and responsibilities of Parties outside of the construction contract.

1.3 SCOPE

A. This Section covers elements, requirements, procedures, and protocols common across all Divisions of the work. Requirements specific to individual Sections are generally specified in the technical specification as well as a dedicated Section for each of Divisions 22, 23, 25 and 26.

B. Specific systems to be commissioned are indicated in the following Divisions of the Specification:
1. Divisions 02–12, 14: Conformance to the following provisions of the Cx requirements is required under Division 01 and this Section:
   a. ‘Equipment and Systems Training’ as required by individual Sections;
   b. Systems Manual preparation and maintenance;
   c. Record Document preparation and maintenance.
2. Division 22 – Plumbing: Requirements for Cx are specified in Section 22 08 00 as well as in individual Division 22 Sections.
3. Division 23 - HVAC: Requirements for Cx are specified in Section 23 08 00 as well as in individual Division 23 Sections.
4. Division 26 – Electrical: Requirements for Cx are specified in Section 26 08 00 as well as in individual Division 26 Sections.
5. Division 25 – BAS: Requirements for Cx are specified in Section 25 08 00 as well as in individual Division 25 Sections.

1.4 RELATED WORK AND DOCUMENTS

A. Commissioning Plan: The Cx Plan outlines responsibilities outside of the construction contract and shall be available to all Parties for reference. It gives the Contractor a perspective with respect to the overall process. It encompasses the entire Cx process including design phase and post construction tasks.

B. Project Manual, Section 12: scheduling requirements related to the Cx process.

C. Project Manual, Section 17: submittal requirements, startup and closeout procedures, operation and maintenance data, warranties, project record documents and training related to the Cx process.

D. Section 01 91 00 – General Commissioning Requirements: Details the Cx requirements common across all divisions.

E. Section 01 91 10 – Functional Testing Procedures: Outlines ‘generic’ Functional Testing Procedures required for specific system types subject to the Cx process.

F. Individual Specification Sections: Individual Sections stipulate installation, start-up, warranty, O&M documentation, and training requirements for the system or device specified in the Section.

G. Section 22 08 00 – Plumbing Systems Commissioning: Details the Cx procedures specific to Plumbing Systems work.

H. Section 23 08 00 – HVAC Systems Commissioning: Details the Cx procedures specific to HVAC work.

I. Section 26 08 00 – Electrical Systems Commissioning: Details the Cx procedures specific to Electrical Systems work.

J. Section 25 08 00 – Building Automation Systems (BAS) Commissioning: Details the Cx procedures specific to the Building Automation System.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Acceptance Phase: This is the phase of the project when the facility and its systems and equipment are inspected, tested, verified, and documented; and when most of the Functional Performance Testing and final training occurs. This will generally occur after the Construction Phase is complete (after Start-Up Documentation has been completed). The Acceptance
Phase begins upon System ‘Turn-Over’ with certification by the Contractor that the systems have been placed into service in accordance with the approved protocols and after the submission of the approved Start-Up Documentation. The Acceptance Phase ends with the successful completion of all Functional Performance Testing and sign-off by the CxA.

B. Action Item (AI): Any Cx-related issue that requires a response, completion, corrective or additional work, or any other action. Examples include a Request for Information (RFI), a work directive, a clarification request, a to-do item, an identified deficiency, or any other like item. Action Items must be categorized as appropriate.

C. Action List: This is a list that is maintained and updated by the CxA that includes all Action Items that relate to Cx activities.

D. A/E: General reference to the Architect/Engineer lead-design entity.

E. ASHRAE: American Society of Heating, Refrigerating, and Air Conditioning Engineers.

F. Basis of Design (BOD) Document: The Basis of Design document is developed by the design team, and shall respond to and be consistent with the performance criteria specified in the Owner’s Project Requirements. The BOD illustrates the means by which the OPR criteria are to be achieved, documenting the assumptions and parameters used in the design, and documenting the primary thought processes or decisions made that resulted in the selected alternatives. At the end of the project, the final BOD content may be incorporated into the Systems Manual if desired in part or in its entirety. The BOD is a required component for LEED-certified projects, and is recommended by ASHRAE for all projects subject to the Cx process.

G. Building Automation System (BAS): The computer-based control or automation system. BAS is used throughout these Sections. Alternate references common in the industry include facility management system, automatic temperature control system, direct digital control system, building management system, building management and control system, digital control system, Energy Management System, Energy Management and Control System or System Control and Data Acquisition (SCADA) System.

H. Checklist Item: An item to inspect to verify proper installation of equipment or systems by the Contractor. Checklist items simply require a ‘Yes/No’ or ‘OK/Not’ response. Start-Up Checklist items are one component of the Start-Up Documentation.

I. Commissioning (Cx): The process of ensuring that all building systems perform interactively according to the design intent, that the systems are efficient and cost effective, and that they meet the Owner’s operational needs.

J. Commissioning Authority (CxA): The Party retained by the Owner who will oversee and manage the Cx process, develop and stipulate many of the Cx requirements, and ensure and validate that systems and equipment are designed, installed and tested to meet the Owner’s requirements.

K. Commissioning Coordinator (CxC): This refers to the Individual within each of the various Parties that is designated the POC for that Party relative to Cx activities. Each of the Contractors subject to the Cx process should designate a CxC and make that person available to the CxA as the point-of-contact for that Contractor.

L. Cx Portal: See ‘Portal’ below.
M. Cx Record Matrix: The Cx Record Matrix provides an ongoing and updated status of the cx program as it is being executed. It is a table of all systems and equipment subject to the Cx process and the status and responsible party of Cx procedures relating to that equipment. Typical fields tracked include equipment tag, location, description, Start-Up Documentation status, FPT status, training status, status of submittals and record drawings, and final Cx disposition.

N. Commissioning Specifications: Generic reference to any of the Cx-specific specification Sections, as inferred by the usage. Divisions 01, 22, 23, 26, and others contain Sections that are specific to or reference the Cx process. All Contractor requirements relating to Cx should be conveyed within the Cx Specs. Cx Specs should be referenced but not duplicated within the Cx Plan (the Cx Plan is designed to govern non-Contractor-related Cx issues).

O. Commissioning Team: The group of Parties involved in the Cx process for any given system. The Cx Team will include a core group involved with all systems, consisting of the CxA and CxC members representing the CM and the Owner. On any given system, the Cx Team will additionally include the CxC’s for the Contractors responsible for the system or equipment.

P. Contractor: As used herein, ‘Contractor’ is a general reference to the installing Party and can therefore refer to the CM, subcontractors, or vendors as inferred by its usage.

Q. Construction Manager (CM): The Party acting as the primary coordinator of all the major subcontractors (MC, EC, TAB, BAC, etc.) as applicable.

R. Construction Phase: Phase of the project during which the facility is constructed and/or when systems and equipment are installed and started. Contractor and subcontractors complete the installation, complete Start-Up Documentation, submit O&M information, establish trends, and perform any other applicable requirements to make systems operational. Contractor and Vendors may also conduct ‘Equipment and Systems Training’ events during this phase. The Construction Phase concludes upon completed Start-Up and TAB of systems and equipment.

S. Contract Documents: The documents governing the responsibilities and relationships between Parties involved in the design and construction of this project including (but not necessarily limited to):
   1. Agreements/Contracts;
   2. Construction Plans and Drawings;
   3. Specifications;
   4. Addenda;
   5. Change Orders;
   6. Commissioning Plan (for reference only)

T. Construction Documents: Refers generally to the Contract Documents that dictate the details of the installation (all but item a. above).

U. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents, does not perform properly or is not complying with the design intent.

V. Design Engineer: Generic reference to the engineer-of-record or a specific engineering disciple as inferred by its usage.

W. Electrical Contractor (EC): Contractor generally responsible for Division 26 work.

X. Factory-Authorized Representative: An individual fully trained on the equipment and certified by the manufacturer to perform the respective task.
Y. Factory Testing: Testing of equipment off-site at the manufacturer’s facility. May be witnessed by the members of the project team.

Z. Functional Completion: A Cx program milestone that marks the successful completion of the FPTs by the CxA and therefore completion of the Acceptance Phase. {This also coincides with the project’s definition of Substantial Completion.} {Functional Completion is a prerequisite for Substantial Completion.}

AA. Functional Performance Tests/Testing (FPT): The detailed and thorough tests (and test procedure) developed and performed by the CxA to document proper operation of building systems and the components and equipment making up those systems during the Acceptance Phase. References made to FPT throughout the documents are inclusive of ISFPT unless specifically indicated otherwise.

BB. IAQ: Indoor Air Quality

CC. LEED (Leadership in Energy and Environmental Design): The LEED® Green Building Rating System is a voluntary, consensus-based rating system designed to encourage building owners to apply leading proven technologies for new construction. Areas of concentration include “Sustainable Sites”, “Water Efficiency”, “Energy and Atmosphere”, “Materials and Resources”, and “Indoor Environmental Quality”. Contractor activities from demolition to procurement to commissioning to waste handling can be impacted by the LEED program.

DD. Manufacturer’s Representative: Either an individual in direct employ of the manufacturer of the applicable system, or an individual who is certified by that manufacturer to perform the applicable work for which the reference is made. This is synonymous with Factory-Authorized Representative.

EE. Mechanical Contractor (MC): Contractor generally responsible for Division 22 and 23 work.

FF. O&M Documentation: Contractor-developed documentation designed to address the needs of facilities personnel and customized for the context of the specific facility and installation. The foundation of O&M Documentation is manufacturer’s literature (O&M Manuals), with additional Contractor-developed step-by-step instructions for manual start/stop, emergency procedures, operating sequences, preventative maintenance, and other installation-specific information. O&M Documentation content is indexed/organized by equipment-type. When a Systems Manual is being developed by the CxA, some of the Contractor-developed content will need to be made available to the CxA for inclusion into the Systems Manual.

GG. O&M Manuals: Generic reference to manufacturer-published O&M materials, which have no information specific to the facility, but may be edited or marked up to indicate specific equipment or systems installed. O&M Manuals include documents covering installation, operation, maintenance, troubleshooting guides, parts numbers, engineering and design parameters, applications manuals, and any/all information available from the manufacturer pertaining to the installed equipment or systems. Specifications should strive for this information to be submitted in electronic form whenever possible. The electronic versions of these documents can also be electronically edited to indicate equipment installed and to delete or mask-over equipment and content that is not installed on the project.

HH. Opposite Season: The season opposite that when the majority of the testing occurs.

II. Owner’s Project Requirements (OPR): The OPR is intended to provide the basis from which all design, construction, acceptance, and operational decisions are made. It details the functional requirements of the project, including systems subject to commissioning. The OPR defines the benchmarks and metrics by which the success of the project is ultimately judged, and evolves
through each project Phase. The OPR is typically developed early in the project cycle by the Owner and the A/E and provides the user needs, requirements, goals, and metrics that are defined by the Owner to be important. The OPR criteria are referenced by and should be the foundation of the BOD narrative. At the end of the project, content the final BOD may be incorporated into the Systems Manual. The OPR/BOD is a required component for LEED-certified projects, and is recommended for all projects subject to the Cx process.

JJ. Party: Entity (company, corporation, etc.) legally responsible for portion of work.

KK. Point-of-Contact (POC): General reference to a key individual within each Party.

LL. Portal: The Cx Portal ('Portal') is a Web-based Internet hub used to electronically collaborate and coordinate activities throughout the Cx process. The Portal is hosted by the CxA and is accessible by all Parties participating in the Cx program.

MM. Prefunctional: The term "Prefunctional" is synonymous with "Start-Up", but not used in these specifications. It is a modifier for checks, tests, and other activities that occur prior to and are prerequisites for Functional Performance Testing.

NN. Preliminary Service: Refers to initial operation of a system or piece of equipment to provide temporary service where initial Start-Up to determine safe operation has been performed. Final TAB and Functional Performance Testing proceeds while the system is in Preliminary Service.

OO. Pre-Test: Preliminary testing accomplished to verify system functionality prior to placing the system/equipment into Preliminary Service.

PP. Project Phases: Phases of the project include the Construction Phase, Acceptance Phase, Warranty Phase, and Occupancy. Earlier Phases include Program Phase and Design Phase.

QQ. RFI: Request for Information.

RR. Start-Up: Refers to the quality control procedures whereby the Contractor verifies the proper installation of a device or piece of equipment, executes the manufacturer's starting procedures, completes the 'Start-Up Checklist', energizes the device, verifies that it is in proper working order and ready for dynamic testing, and completes the 'Start-Up Tests'. Start-Up procedures are performed by the Contractor with or without a formal Cx process, although the documentation is more formalized when the Cx process is used.

SS. Start-Up Checklist: A list of items to inspect to verify proper installation of equipment or systems by the Contractor. Checklist items simply require a 'Yes/No' or 'OK/Not' response. These include primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension checked, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). Start-Up Checklist items are one component of the Start-Up Documentation (Start-Up Tests being the other).

TT. Start-Up Documentation: Refers to the combination of Start-Up Checklists + Start-Up Tests. The Contractor documents the Start-Up procedure by completing and submitting the Start-Up Documentation. Start-Up Documentation may be a combination of procedures prepared by the CxA, those included in the Contractors in-house quality assurance process, and those required by the manufacturer. Regardless of the context of the checklist or format of the form used to documents it, the reference to 'Start-Up Documentation' includes all of the stated checklists and tests.

UU. Start-Up Test: This is a quality-assurance test that is required to ensure the system is ready to be placed into service. It differs from a checklist item in that it requires more than a binary
(yes/no, OK/Not OK) response - an observation, measurement, or sequence of events must be documented. Start-Up Tests are one component of the Start-Up Documentation (Start-Up Checklists being the other).

VV. Substantial Completion: Milestone as defined in the Owner-Contractor agreement and Specifications. This milestone will coincide with the end of the Acceptance Period. This milestone also coincides with the start of the Warranty Period.

WW. System Turn-Over Meeting (“Turn-Over”): Turn-Over is a quality control milestone in which all Contractors responsible for completing the installation and start-up of a system or equipment, along with the DM and CM, meet to validate that the system or equipment is completed and operational per the contract documents and ready for Functional Performance Testing, and that all the Start-Up Documentation and nameplate data is complete and accurate. The CxA will in many cases participate in this. CM shall organize and lead the process in all cases.

XX. Systems Manual: The Systems Manual is the final deliverable from the Cx process, and provides the information needed to understand, operate, and maintain the facility and its systems. It is typically developed by the CxA or A/E, but with content required to be provided by the design team and the Contractors. The Systems Manual expands the scope of standard O&M documentation to incorporate additional information developed through the Cx process. The Systems Manual should be the repository of all updates and corrections as they occur (even throughout Occupancy). It is narrative in nature and organized by system types and by area/usage of the facility (if applicable). Systems Manual content typically includes narrative descriptions of the facility and systems, sequences of operation, schematic diagrams, cuts from design drawings and equipment literature, photos, and manual start/stop and emergency operating procedures for important equipment. The content of the Systems Manual is dictated by budget, and usually consists of a single narrative document with references to and inclusive of the entire set of O&M and Training materials.

YY. Test: A task, procedure or measurement that confirms capacity, functionality, accuracy, etc. Tests have a status of “Pass”, “Fail”, “Couldn’t Test” or “Didn’t Test”. May refer to Start-Up or Functional Performance Tests.

ZZ. TAB: Can refer to the test, adjust, and balance process or the Testing, Adjusting, and Balancing Contractor as inferred by its usage.

AAA. Temporary Conditioning Plan: A plan that summarizes the logistics, procedures and protocols for taking permanent equipment and using it to maintain conditions throughout construction. The Temporary Conditioning Plan must be approved by all members of the Cx Team prior to placing equipment into temporary service.

BBB. Testing Agency: An independent agency typically retained by the Contractor to perform specialized testing of systems or equipment (most commonly electrical). The Testing Agency shall be qualified and equipped to perform the testing and shall submit appropriate qualifications.

CCC. Trending: Monitoring and recording a history of parameters typically using the building automation system.

DDD. Turn-Over: See “System Turn-Over Meeting” above.

EEE. Vendor: Refers to the organization that sold a system or equipment to the subcontractor. This may be a branch office of the manufacturer or a value-added reseller.
FFF. Warranty Period: The period defined by the construction documents where elements of the facility are under contractual warranty.

GGG. Warranty Phase: Includes the early occupancy of the building and can continue through the contractual Warranty Period and at least into the opposite season from when the facility systems were initially tested.

1.6 REFERENCE STANDARDS

A. ASHRAE Guideline 0-120056, "The Commissioning Process"
B. ASHRAE Guideline 4-1993, “Preparation of operating and Maintenance Documentation for Building Systems”
C. NEBB - Procedural Standards for Building Systems Commissioning
D. USGBC - LEED New Construction and Major Renovation Reference Guide (Version 2.2)

1.7 DOCUMENTATION

A. Contractor shall provide the following documentation to the CxA per the procedures specified herein and in other Sections of the specification:

1. Shop Drawings and Product Data: CxA shall be provided shop drawings and submittal data for systems and equipment that will be part of the Cx process. Some of these submittals will be reviewed by the CxA and others are only needed for record. CxA will mark up the Submittal Register to indicate the documents required. Electronic format shall be in PDF format and shall be capable of allowing electronic comments and markups.
   a. Submittals to be Reviewed: CM shall provide the CxA one electronic copy of Shop Drawings and Product Data concurrent with distribution to the A/E. CxA shall review and incorporate comments via the A/E. CM shall then copy CxA with the final reviewed submittal with A/E approval stamp.
   b. Submittals for Record: CM shall provide to the CxA the final electronic record copy of the submittal.

2. Draft Start-Up Documentation: Contractor shall develop Start-up Documentation for all applicable equipment and systems along with the manufacturer’s application, installation and recommended start-up procedures. CxA will initially provide to the Contractor generic Start-up Checklists, the content of which must be reviewed by the Contractor and supplemented with manufacturer-specific requirements and the Contractor’s own internal quality assurance procedures and checks. CxA will review draft and recommend approval.

3. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase.

4. Schedule Updates: Issue periodic updates to the construction schedule as specified. Provide electronic copy of each update to the CxA. Contractor shall use schedule updates to notify Cx Team of scheduled start-up and training activities.

5. Temporary Operating and Conditioning Plan: Contractor shall provide initial Temporary Operating and Conditioning Plan for approval and then issue periodic updates to reflect actual conditions. At the completion of the temporary conditioning period, the final plan shall be submitted with completed maintenance records, inspection and check logs, operating logs, and narrative of any problems or issues that occurred during Temporary Conditioning (if applicable).
6. Piping Cleaning, Flush, and Fill Plan: Contractor shall provide Piping Cleaning, Flush, and Fill Plan for approval at least 30 days prior to final cleaning, flush, and fill.

7. Action Item Response: Respond to Action Items to which the CxA assigns responsibility to the Contractor.

8. Field Testing Agency Reports. Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase.

9. Completed Start-Up Documentation: Provide completed Start-Up Documentation for all applicable equipment and systems. Provide prior to the start of the Acceptance Phase. CxA will review prior to FPT. Completed Start-Up Documentation shall be entered by the Contractor on the Portal.

10. Nameplate Data Documentation: Provide prior to the start of the Acceptance Phase. Completed nameplate data shall be entered by the Contractor on the Portal.

11. Equipment Warrantees: Provide prior to the start of the Acceptance Phase.

12. Training Plan: Provide prior to the start of the Acceptance Phase.

13. Record Training Documentation: Provide at least 7 days prior to the start of the applicable training session. The compiled and final record training documentation will be provided by the CM within 14 days of the last training session provided under the construction contract (this will typically be the site-specific controls training). This will take the form of the Training Plan supplemented with evaluations and actual dates and topics.

14. O&M Documentation Content: Provide O&M Documentation content (including installation-specific instructions) to the CxA for incorporation into the Systems Manual per the requirements of this Section, and Division 01 requirements. Submit at least one month prior to the beginning of the Acceptance Phase.

B. Record Drawings: Contractor shall maintain an updated set of record or ‘As-Built’ documents at the jobsite and electronically online reflecting actual installed conditions and all approved changes and modifications to the contract documents. Contractor shall provide access to the CxA to review the As-Built and Record Drawings. Provide Record Drawings in accordance with Division 01.

1.8 COMMISSIONING SEQUENCING AND SCHEDULING

A. Refer to the sequencing illustration at the end of this Section for a conceptual graphical representation of the precedents related to the Cx tasks. These precedents are generally to be applied per system and/or per area. Where applicable, in order to expedite the closeout of the facility, various systems can be in various stages of the Cx process. CxA and Contractor shall cooperate to schedule the Cx tasks to minimize the duration of the Cx activities.

B. The Cx process will be categorized into Phases as indicated below and defined under the definitions paragraph above. Note that per schedule, different systems and/or areas may be in different phases at any given time given that the Cx program will be integrated into the construction process:
   1. Construction Phase
   2. Acceptance Phase
   3. Warranty Period

C. CxA will provide a more detailed precedent diagram in Gantt chart format for direction of Cx precedents and task duration.

D. Prior to submission of the baseline schedule, the scheduler will coordinate with the CxA to specifically include the detailed tasks involved in the Cx process. CxA will provide an initial “Precedent Diagram” that outlines the optimal Cx process. Scheduler shall meet with the CxA and the subcontractors to synthesize the Precedent Diagram with the general construction
process constraints and integrate the agreed upon process into the main construction schedule. Commissioning-related tasks shall be coded as such to facilitate generating a Cx fragment that will be used during Cx progress meetings.

E. The Cx precedent schedule will outline generic Cx tasks with precedents or prerequisites to each task. These tasks, which will be shown generically for typical systems, will apply to many systems. Contractor shall incorporate the tasks into EACH SYSTEM. This will require a detailed track for each system and as such the scheduler must schedule and code by system as well as by area. The Cx precedent diagram will also indicate system precedent requirements for start-up and Functional Performance Testing. Contractor shall collaborate with the CxA to determine impacts of project phasing as applicable. Examples of enumerated tasks include:

1. Contractor preparation of draft Start-Up Documentation;
2. Contractor preparation of Training Plan;
3. Preparation of O&M Documentation content and other content for the Systems Manual;
4. Testing Agency activities;
5. Electrical Start-Up by system and zone group;
6. Mechanical Start-Up by system and zone group;
7. BAS Start-Up by system and zone group;
8. TAB by system and zone group;
9. Training Events;
10. Functional Performance Testing by system and zone group.

F. Contractor shall completely install; thoroughly inspect; start-up; and test, adjust, and balance systems and equipment. All activities shall be documented per specified procedures and progress tracked on the construction schedule.

G. Contractor shall notify CxA at least 14 days in advance for all system and equipment Start-Ups, training, pressure tests, or system flush and fill. At their discretion, the CxA shall witness selected Start-Ups, training events, or tests. Notification shall be accompanied by a schedule showing the coordinated start date and task duration and all currently open precedent requirements.

H. CM shall schedule and conduct System Turn-Over Meetings for all systems and equipment in the Cx scope as specified below. CM shall notify CxA, DM, A/E, and Owner in writing that systems are complete and ready for verification and Functional Performance Testing.

I. Notification of utility or system outages affecting current mission shall require advance notification per applicable Division 01 section.

1.9 SYSTEM TURN-OVER MEETINGS ('TURN-OVER')

A. CM shall schedule and conduct System Turn-Over Meetings ('Turn-Over') for all systems and equipment. Turn-Over is a quality control milestone in which all Contractors responsible for completing the installation and start-up of a system or equipment, along with the DM and CM, meet to validate that the system or equipment is completed and operational per the contract documents and ready for Functional Performance Testing, and that all the Start-Up Documentation and nameplate data has been completed and is accurate. The CxA will in many cases participate in this. CM shall organize and lead the process in all cases.

B. Notification shall be given of all System Turn-Over Meetings to the CxA and the Owner via an Action Item posted on the Portal at least 14 days in advance of the activity. CxA and Owner may elect to witness the Turn-Over, although it is not required. Primary responsibility of confirmation of the represented state of the equipment lies with the CM.
1.10 ELECTRONIC RECORD SUBMITTALS

A. Contractor shall submit a final electronic version of the submittal for Owner’s future asset management within 14 calendar days after receipt of approval from the Owner and the Architect on any submittal for equipment in Divisions 22, 23, 25, and 26.

B. Final Electronic Record Submittals shall:
1. Be originally authored in electronic media and not scanned versions with hand mark-ups unless specifically approved otherwise.
2. Be provided in Portable Document Format (*.pdf) with selectable text and graphics that are readable. The documents shall be merged into one bookmarked document up to 500 MB. Merged documents shall use hierarchical bookmarks to form a table of contents and provide hyperlinks to the subject topic. For submittals larger than 500 MB, provide a summary document in PDF or HTML format with relative hyperlinks to the associated document files within the same directory or in directories subordinate to the summary document.
3. Include all final ratings, parameters, specifications, options, etc. In the case where the Architect returns the submittal “Approved As Noted, Resubmission Not Required” and includes mark-ups or comments that change the originally submitted ratings, parameters, specifications, options, etc., the Contractor shall correct the documents in the original electronic document prior to submitting the final electronic documents.
4. Highlight the specific rating, parameter, specification, option, etc. when the original document includes multiple alternatives. For instance, when a range of performance parameters are given or various sizes are shown, or various options are listed, the applicable item shall be indicated by highlight, circle, pointer, or other electronic marking. Partial-page material in the submittal that does not pertain to the project can be masked with a transparent gray screen over the text; entire pages that are not applicable may be electronically deleted.
5. Do not include generalized direction from the Architect that does not relate to ordering and purchasing the equipment. For instance, notes such as “Coordinate with mechanical engineer for final motor horsepower” are not to be transferred to the electronic submittal. In that example, only the final coordinated sizes shall be indicated.

C. Final Electronic Record Submittals shall be either posted to the project web site or provided on compact disc.

1.11 COORDINATION MANAGEMENT PROTOCOLS RELATIVE TO COMMISSIONING

A. Coordination responsibilities and management protocols relative to Cx are initially defined below but will be refined and documented in the Construction Phase Cx Kick Off meeting. Contractor shall have input in the protocols and all Parties will commit to process and scheduling obligations. The CxA will record and distribute.
1. Submittals and Shop Drawings: CM shall distribute these to the CxA. CxA shall edit the project’s submittal log to communicate which submittals must be forwarded to CxA.
2. CxA Review Comments on Shop Drawings: Comments shall be posted on the Portal and a copy sent directly to the A/E and CM by the CxA. A/E shall consider and incorporate at their discretion.
3. Deficiencies Identified by the CxA: When the CxA identifies a deficiency, CxA shall make a good faith assessment of responsible parties. Those parties, as well as CM shall be notified of the perceived deficiency. This communication is FOR INFORMATION ONLY and is not a directive to any party to resolve the deficiency. Contractor may accept responsibility and resolve the deficiency voluntarily. If Contractor contests either the deficiency or responsibility for that deficiency, Contractor shall respond to that deficiency indicating disagreement. If responsibility is not agreed to via the Cx dialogue, PSU shall issue a work directive or RFI via the normal contractual channels to resolve the issue.
4. Requests for Meetings: Request by the Contractor for a meeting with the CxA shall be routed through CM who will then determine the validity. Note that every attempt should be made to deal with Cx issues at regularly scheduled Cx Meetings.

5. Control Sequence Modifications: CxA shall make every attempt to thoroughly review the sequences during the submittal phase and address any issues prior to the submittal approval. However, CxA and the BAC may incorporate minor changes to the sequence during testing when it is apparent that it improves the control of the equipment but does not fundamentally change the sequence. The time required by the BAC for this type of modification is addressed in Section 23 08 00. Any and all changes must be thoroughly documented in the record documents.

6. Scheduling Coordination: CxA shall consult directly with the CM to incorporate the Cx tasks in the project schedule. The process logic and integration shall ultimately be a collaboration between CM, CxA, and subcontractors. The effort will start with CxA and CM proposing initial logic. Then subcontractors will join the discussion and work out the final details, (precedent logic and durations).

7. Notification of Completion Milestones: Contractor shall notify CM at least two weeks prior to an anticipated Cx activity or milestone (such as Turn-Over). CM shall then coordinate the scheduling of the activity (as applicable) between all required parties as applicable. Notification shall be posted using the Portal (events module) with an associated Action Item distributed to interested parties.

8. Action List: CxA maintains a categorized Action List which tracks the Cx-related action items. All content of the Action List will be available to all parties who have credentials on the Portal. Any party with credentials may post an Action Item. Any party that is copied on an email resulting from an Action Item posting may respond to it and contribute to the dialogue.

9. Start-Up Checklist and Test Documents: CxA will provide initial 'generic' Start-Up Documents to the Contractor. The Contractor shall synthesize these with the manufacturer-specific start-up procedures and submit both to the CxA for review and approval. The Contractor has the option of modifying the supplied generic procedures in the delivered format, or by supplementing these with their own procedures. The Contractor then executes, signs, and submits the final reviewed and approved Start-Up Documentation. The CxA subsequently (and optionally) spot-checks the procedures and documentation at the ‘System Turn-Over Meeting’. The Start-Up Documentation is then included in the Commissioning Record.

10. Functional Performance Test Documents: Functional Performance Tests are prepared and completed by the CxA. They are developed during the construction phase, typically after completed submittals. CxA forwards the FPT procedures to the CM to be subsequently distributed to the Contractors for review. Contractors approve the procedures. Throughout the Cx process, CxA maintains a current record of the FPTs and their results and keeps the documentation up to date and accessible for all to access the current progress. CxA distributes hard copies of the FPTs at the completion of any significant stage of commissioning.

1.12 CONTRACTOR RESPONSIBILITIES

A. Construction Phase: The following delineates the commissioning-related responsibilities of the Contractor (and their subcontractors) during the Construction Phase.

1. Include Cx requirements in price and plan for work.

2. Designate a Commissioning Coordinator (CxC) from each major subcontractor with activities related to commissioning. These Commissioning Coordinators are to be the primary contacts for Cx activities.

3. Attend Construction Phase Cx Kick Off Meeting. The CxC and Project Manager from each major subcontractor shall attend.

4. The CxC’s shall attend all Cx progress meetings unless otherwise agreed to by the CxA.

5. Remedy any deficiencies identified throughout construction.

6. TAB shall submit sample balancing forms for approval prior to starting work.
7. Schedule and coordinate Cx efforts into the construction schedule. Incorporate the precedent diagram provided by the CxA into the construction schedule. Indicate at a minimum all tasks enumerated on the precedent diagram for all systems.

8. Coordinate the work of subcontractors, vendors, manufacturers, and Testing Agencies provided with the bid, and ensure that they are informed of and are adhering to the requirements of the Cx process specified throughout the contract documents.

9. Contractor-Developed Documentation: Contractor shall develop and submit the following information as specified:
   a. Draft Start-Up Documentation (submit along with the manufacturer's application, installation and start-up procedures);
   b. O&M Documentation content as specified;
   c. Systems Manual content as specified;
   d. Training Plan, and materials and documentation of training;
   e. Temporary Operating and Conditioning Plan, if applicable, content as specified;
   f. Piping Cleaning, Flush, and Fill Plan, content as specified;
   g. Comprehensive integrated procedures for scheduling and task notification and documenting them in a common format.

10. Provide assistance to the CxA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.

11. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this Section.

12. Start-up, test, adjust, and balance systems and equipment prior to verification and Functional Performance Testing by the CxA. Start-Up Documentation shall be in accordance with Contract Documents, reference or industry standards, and specifically individual Cx specifications. Provide skilled technicians qualified to do the work required. Provide factory trained/authorized technicians where required by the contract documents and stated in the applicable technical section. Start-Up and Functional Performance Testing shall proceed from device checkout, to component checkout, to system checkout, to inter-system checkout.

13. Prepare spaces with adequate security for on-site contractors to store equipment. Provide secure space with 120 volt AC power for the CxA, TAB, and BAC to base their operations and store test equipment, drawings, files, and the like.

14. Schedule for any required representative space mock-ups as early as possible to facilitate determining standards for closeout.

15. Record Start-Up procedures on approved Start-Up Documentation and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above. Each task or item shall be indicated with the party actually performing the task or procedure.

16. Provide skilled technicians qualified to perform the work required.

17. Provide factory-trained and authorized technicians where required by the Contract Documents.

18. Tag equipment that is started with the Individual’s name and date.

19. Demonstrate the operation of all systems as specified.

20. Certify that systems have been installed and are operating per Contract Documents prior to Functional Performance Testing.

21. Maintain an updated set of Record Documentation as required by the Contract Documents.

22. Copy the CxA on indicated documentation.

23. Conduct and document Equipment and Systems Training events as required by this Section and by applicable sections of the Specifications pertaining to each piece of equipment or system.
B. Acceptance Phase: The following delineates the Cx-related responsibilities of the Contractor (and their subcontractors) during the Acceptance Phase.
1. Assist CxA in Functional Performance Testing. Assistance will generally include the following:
   a. Manipulate systems, equipment, BAS, and other control systems to facilitate testing (as dictated in Section 01 91 10; in most cases this will entail only an initial sample).
   b. Provide any specialized instrumentation necessary for Functional Performance Testing.
2. Correct any work not in accordance with Contract Documents.
3. Participate in Training Events relative to use of O&M information and the preventative maintenance program.
4. Maintain record documentation, and update and resubmit it when Acceptance Phase is completed.
5. Compensate CxA for additional site time incurred due to incompleteness of systems or equipment at time of Functional Performance Testing.

C. Warranty Phase: The following delineates the Cx-related responsibilities of the Contractor (and their subcontractors) during the Warranty Phase.
1. Provide warranty service;
2. Conduct Final Systems Operation Training (BAC lead);
3. Respond to and document warranty issues;
4. Participate as required in opposite season testing;
5. Correct any deficiencies identified throughout the Warranty Phase;
6. Update record documentation to reflect any changes made throughout the Warranty Phase and resubmit final Record Drawings at the close of the Warranty Phase.

1.13 EQUIPMENT SUPPLIER/VENDOR RESPONSIBILITIES

A. Construction Phase: The following delineates the Cx-related responsibilities of the Equipment Supplier (and their subcontractors) during the Construction Phase.
1. Provide shop drawings and product data in hard copy and electronic format.
2. Provide manufacturer’s application, installation and start-up instructions within 30 days of shop drawing/product data approval.
3. Where factory-authorized start-up is specified, coordinate and participate in the specified Cx process and document start-up on the appropriate forms.
4. Review and approve Functional Performance Test procedures affecting supplied equipment.
5. Where training is to be provided by factory-authorized personnel, provide required Training Plan information including course content for approval prior to conducting the training.
6. Conduct and document Equipment and Systems Training events as required by this Section and Section 01 82 00, and by applicable sections of the Specifications pertaining to each piece of equipment or system.
7. Provide spare parts and materials as required by the specifications.
8. Provide special tools as required by the specifications.
9. Provide Systems Manual content as required and develop project-specific O&M content as required by the Cx requirements.
10. Provide all warranties.

B. Acceptance Phase: The following delineates the Cx-related responsibilities of the Equipment Supplier (and their subcontractors) during the Acceptance Phase.
1. Participate in any Functional Performance Testing required.
2. Consult on issues identified relative to the supplied equipment.
C. Warranty Phase: The following delineates the Cx-related responsibilities of the Equipment Supplier (and their subcontractors) during the Warranty Phase.
   1. Provide any warranty service required to the supplied equipment as applicable with the agreement with the Contractor.
   3. Provide technical support to the Owner’s facilities personnel.

1.14 COMMISSIONING KICK OFF/COORDINATION MEETING

A. CxA shall schedule and conduct a Cx coordination meeting near the beginning of construction. The following should be discussed at this meeting:
   1. The commissioning documents (specifications and Cx Plan);
   2. Requirements and sequence of commissioning;
   3. Responsibilities of the construction parties;
   4. Management protocols;
   5. Required submittals;
   6. Schedule

1.15 START-UP DOCUMENTATION AND START-UP PROCESS

A. Purpose: The Cx process requires that the normal quality control processes involved with preparing systems and equipment for operation are performed to a high standard of care and are thoroughly documented. The required Cx-related Start-Up Documentation involves nothing additional than that which would be done for any good installation. These procedures shall be performed to all installed systems and equipment and no sampling strategy is used for the Start-Up process. The Cx process requires all Parties to collaborate to establish the optimal standard of care for starting systems and equipment. After the procedures are established, the Contractor performs them and documents them with the Start-Up Documentation that is developed by the joint effort of the Contractor and the CxA.

B. Creation of Start-Up Documentation: Start-Up Documentation (consisting of checklists and tests as defined above) shall be developed by the Contractor and appropriate manufacturers for each type of equipment and system being installed for this project. It shall be submitted to the CxA for approval prior to actual equipment Start-Up. Contractor shall develop Start-Up Documentation based upon a combination of the ‘generic’ procedures prepared by the CxA (see below): existing procedures and checklists included in the Contractors in-house quality assurance process, and those procedures required by the manufacturer. Contractor shall provide the CxA with either 4 hard copies or one electronic copy of manufacturer’s application, installation and start-up information at the time they submit the Start-Up Documentation. The CxA shall then approve the Start-Up Documentation. Approved Start-Up Documentation shall reflect all project-specific values, settings, targets, acceptance criteria, and other parameters as appropriate. Final approved Start-Up Documentation shall be entered on to the Portal by the [CxA] [CM] [Contractor].

C. ‘Generic’ Start-Up Documentation: Refer to Sections 23 08 00 and 26 08 00 for ‘generic’ Start-Up Documentation for a variety of HVAC, mechanical and electrical systems. The content of the ‘generic’ Start-Up Documentation shall provide the minimally acceptable content. Generic refers to the fact that these procedures and protocols are common for most types of equipment and systems across different manufacturers. The Contractor is responsible for customizing this material to reflect the actual equipment and systems selected.

D. Manufacturer/Vendor Installation and Start-Up Documentation: Contractor and Vendors shall provide manufacturer’s preprinted and standard installation checklists, forms, and protocols both for review early in the construction process and to as required to document the Start-Up process towards the end of the Construction Phase. After the approval of the shop drawings
and product data, Contractor shall submit manufacturer’s start-up procedures and application
guidelines for all systems, equipment, and components. These shall be submitted in electronic
PDF format for review and approval. Submittal of the information shall be within 30 days of the
submittal approval.

E. Content of Start-Up Documentation: Start-Up Documentation shall generally include the
following for each item of equipment or system (as applicable):
1. Project-specific designation, location and service;
2. Indication of the Party performing and documenting the Start-Up;
3. Clear explanation of the inspection, test, measurement, and outcome with a Pass/Fail
indication and a record of measured parameters (as applicable);
4. Include a checklist item indicating that all O&M Documentation, Warranties, and Record
Documents have been completed and submitted;
5. Include a Start-up Checklist item indicating that proper maintenance clearances have
been maintained;
6. Include a Start-up Checklist item indicating that special tools and/or spare tools required
for normal operation and maintenance were turned over to the Owner;
7. Include Start-up Checklist item indicating that all required dependent or prerequisite
equipment and systems were previously started successfully.

F. Manufacturer’s Requirements: Start-Up Documentation shall incorporate all manufacturer-
specified procedures. As applicable, include acceptance criteria specified therein. The
manufacturer’s start-up and checkout procedures shall be submitted to the CxA along with the
Contractor’s draft Start-Up Documentation.

G. Recording and Documentation of the Start-Up: Manufacturer’s start-up protocols shall be
executed and forms shall be completed by a qualified/authorized technician. These shall be
developed and submitted electronically or at the discretion of the CxA they may be scanned and
submitted electronically. Electronic documentation of manufacturer’s start-up protocols shall be
linked into the applicable test on the Portal.

H. Recording and Completion of Start-Up Checklists and Tests: A qualified technician from the
responsible installing Contractor or manufacturer’s start-up technician shall document the Start-
Up on the approved Start-Up Documentation forms. The individuals executing the Start-Up
shall acknowledge acceptability of each item with the indication of who performed the
associated task. The Start-Up is not considered complete until the Start-Up Documentation has
been completed and entered electronically on the Portal. Information documented manually on
paper in the field and/or installation or start-up information developed by the manufacturer must
be transferred to the electronic file before Turn-Over can be scheduled. The completed
documentation shall be presented and reviewed at the System Turn-Over Meeting.

I. CxA Review: CxA shall review the completed and submitted Start-Up Documentation and
request any incomplete data or additional information required to meet the Cx program criteria.
CxA will also review and spot-check procedures during Functional Performance Testing.

J. Systems Subject to Start-Up Documentation and Turn-Over: All (100% of) systems shall
undergo a documented Start-Up per the approved procedures and NO sampling strategy is
used. Completed Start-Up Documentation for all pieces of equipment shall be submitted to CxA
prior to Turn-Over or any associated Functional Performance Testing. Any outstanding item
shall be clearly indicated and an associated Action Item must be entered to track resolution.

K. Owner Access: Contractor shall allow access by Owner representatives at any time to inspect
the equipment and ensure its proper operation. Owner will be allowed to affix service tags to
equipment to track the proper maintenance.
1.16 MECHANICAL-SPECIFIC DOCUMENTATION REQUIREMENTS

A. The Division 23 Contractor shall provide the following documents as specified in Section 23 08 00:
1. Piping Cleaning, Flush, and Fill Plan
2. Temporary Operation and Conditioning Plan (if permanent systems are to be used to condition the building during Construction Phase)

1.17 EQUIPMENT NAMEPLATE DATA

A. Contractor shall provide as-installed specific product nameplate data, product numbers, serial numbers, and other information required to fully define the asset for Owner’s use in maintenance management and asset tracking. This data shall be provided electronically to ease in the data transfer to the computerized maintenance management system.

1. Acceptable forms of electronic submittals are:
   a. Microsoft Excel spreadsheet arranged with a separate ‘Sheet’ for each type of equipment and with individual pieces of equipment entered as rows and the applicable values to be recorded as column headings.

2. Minimum nameplate data content shall include the following as applicable:
   a. Construction document designation;
   b. Owner’s designation if different than the construction document designation and if provided by the Owner;
   c. Contact information identification which shall reference the project’s Contact List for installing contractor, vendor or representative, and manufacturer. Contractor shall also provide identification for suppliers of parts if different from the previous parties.
   d. Model Number;
   e. Serial Number;
   f. Date of Manufacture;
   g. All performance and sizing data required to operate, diagnose, or replace the system, equipment, component or systems with as a minimum that indicated in the construction documents.
   h. General description or type classification of the system, equipment, component, or device.

B. Contractor shall provide Equipment Nameplate Data for all equipment provided as work of this Division.

1.18 FUNCTIONAL PERFORMANCE TESTING

A. The objective of Functional Performance Testing is to demonstrate that each system is operating according to the documented OPR/Basis of Design and Contract Documents. Functional Performance Testing facilitates bringing the systems from completed Start-Up to Functional Completion. During the FPT, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems. System parameters are further tuned and optimized to provide for stable control and interrelated system effects are also addressed.

B. The logistics and procedures involved in Functional Performance Testing are outlined below and in Section 01 91 10.

1.19 DEFICIENCIES IDENTIFIED DURING FUNCTIONAL TESTING

A. Non-Conformance Deficiencies. Non-conformance deficiencies identified during Functional Performance Testing shall be resolved as follows:
1. The CxA will record the results of the functional test in the project database on the Portal. All deficiencies or non-conformance issues shall be noted as Action Items and reported to the CM.

2. Corrections of identified minor deficiencies may be made during the tests at the discretion of the CxA. In such cases, both the deficiency and associated resolution will be documented in the database.

3. Every effort will be made by the CxA to expedite the FPT process and minimize unnecessary delays, while not compromising the integrity of the procedures.

4. As tests progress and a deficiency is identified, the CxA will discuss the issue with the executing Contractor.
   a. When there is no dispute on the deficiency and the Contractor accepts responsibility to correct it:
      1) The CxA shall document the deficiency along with the Contractor’s response and intentions, and then proceed forward to another test. A copy/email of the deficiency shall be generated and provided to the Contractor and CxA. The Contractor shall then correct the deficiency, complete the Action Item response certifying that the issue is resolved and/or the equipment is ready to be retested, and sends it back to the CxA.
      2) The CxA reschedules the test and the test is repeated until satisfactory performance is achieved. CxA then closes the Action Item.
   b. If there is a dispute about a deficiency, regarding whether it is a deficiency and/or who is responsible:
      1) The deficiency shall be documented as an Action Item with the Contractor’s response and the CM will be notified. The CM will track this issue under the construction contract dispute resolution provisions.
      2) Final interpretive authority is with the A/E. Final acceptance authority is with PSU.
      3) The CxA documents the resolution to the Action Item.
      4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, and responds to the Action Item indicating completion. The CxA reschedules the test and the test is repeated until satisfactory performance is achieved. CxA then closes the Action Item.

B. Cost of Retesting: The cost for the CxA to retest a Start-Up or Functional Performance Test shall be paid by the Contractor responsible for the deficiency. PSU shall pay the CxA directly and back charge the responsible Contractor.

C. Failure Due to Manufacturer’s Defects. If 10% or three, whichever is greater, of identical pieces of equipment fail to perform to the required Contract Document criteria (mechanically or substantively) due to manufacturing defect, all identical units may be considered unacceptable by the Owner. (For the purposes of defining ‘identical equipment’ for this Section, size or capacity alone does not constitute a difference.) In case of failure due to manufacturer’s defects, the Contractor shall provide the Owner with the following:
1. Manufacturer’s response in writing as to the cause of the failure and proposed resolution.
2. Manufacturer shall implement their proposed resolution on a representative sample of the product.
3. PSU will determine whether a replacement of all identical units or a repair is acceptable.
4. Upon acceptance, the manufacturer shall replace or repair all identical items at their expense and shall extend the warranty accordingly (if the original equipment warranty had begun).
5. Manufacturer or Contractor shall pay the costs of all retesting necessitated by the failure.

1.20 OBSERVATION PERIOD FOR BAS STABILITY

A. General: The Observation Period is defined as the period of time either prior to or immediately following Functional Performance Testing where the BAS is shown to operate properly without
malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these specifications.

B. Prerequisites: The CxA will determine when the BAS has been substantially completed to allow for the start of an informal Observation Period as defined above. Observation Period may be witnessed in phases only on larger more complex projects where interdependencies between phases are not a factor.

1.21 TRAINING EVENTS

A. General: Adequate and thorough training of the Operators and the facilities staff is vital to effective transition and early occupancy of the building. A key goal of the Cx program is to ensure that this is accomplished. Contractors, subcontractors, and Manufacturers/Vendors as specified shall prepare and conduct training sessions on the installed systems and equipment for which they are responsible. The Contractor shall be responsible for insuring all training is performed in accordance with the Contract Documents.

B. Training Events Overview. Training Events include all classroom and field-based training sessions that result in the training or transference of design team or Contractor knowledge to the Owner. The following Training Events shall be executed as part of the Training Program:

1. Design Orientation Training: The purpose of the one-time Design Orientation Training event is to acquaint the Owner and Contractors with the facility design strategies and approach taken by the Design Team. The mechanical design engineer is responsible for conducting and documenting this training, with assistance and support from the CxA. Material from the Owner’s Project Requirements and Basis of Design Documents shall be covered during this training. An overview of the facility and its systems, the system design goals and the reasoning behind the selection of the equipment will be reviewed. The CxA will also review the upcoming Start-Up process and FPT/Acceptance Testing procedures. An optional tour will be provided at the conclusion of the event.

2. Equipment and Systems Training: The Contractor (or Manufacturer’s Representative) shall provide training to the Owner/Operators on individual systems and equipment only after successful Start-Up. These training events cover proper operation, maintenance, repair, and diagnosis of the systems, equipment, and components installed by the Contractor. Details and required content are provided elsewhere in this Section.

3. Final Systems Operation Training: The BAC shall provide this training to the Owner and Operators on whole-building operation. This training shall focus primarily on BAS control of building systems and operation and its impact on building performance, and shall be conducted after Functional Completion.

C. Training Means, Methods, and Documentation: The Contractor must document all training sessions. Details on the means and methods for conducting and documenting training, including location requirements, preparation, methods for presentation, scheduling, instructor qualifications, and other details are specified below.

1. Setting: Training sessions should typically start and end in a classroom setting. Field demonstrations shall be conducted to demonstrate the hands-on aspects of the required tasks.

2. Presentation: Training shall include electronic presentation materials. Presentation materials shall be submitted by the Contractor with the Training Plan. Contractor shall provide audio/visual equipment as required to communicate to a minimum of 10 attendees.

3. Documentation: Subcontractors or Vendors must document the training sessions in a Training Record. Beyond that included in the Training Plan, documentation shall include the names of the attendees and their evaluations. Training shall follow handouts that list the key points in bullet form presentation style or follow detailed written documentation. Training will not be approved unless it contains accompanying handout documentation to every attendee for their own use and record, separate from the master copy for the
4. Evaluations: All training sessions must be evaluated by the participants. CxA shall develop an evaluation form that assesses the quality of the presentation, the quality of the content, and provides a forum for feedback of items the attendee feels should be provided or expanded on. The Contractor that organizes the sessions is responsible for distributing the evaluations, ensuring they are completed, and compiling them and forwarding them to the CxA.

D. Training Plan Document
1. The Training Plan shall outline the various Equipment and Systems Training events and Final Systems Operation Training event as proposed by the Contractors, and shall be approved by the CxA. Contractor shall compile the individual training agendas of the subcontractors and vendors and submit a comprehensive Training Plan to the CxA, Architect and the Owner for review. Training Plan shall summarize all Equipment and Systems Training events with topics to be covered and approximate training duration.
2. The Training Plan shall include at a minimum:
   a. Topic and applicable specification section;
   b. Scheduled date(s) for the Events(s);
   c. Location and setting (classroom or field);
   d. Lead instructor and instructors qualifications;
   e. Co-instructors and their qualifications;
   f. Training objective;
   g. Event outline/agenda;
   h. Detailed breakout of content to be presented;
   i. Anticipated duration;
   j. Required attendees for each session.
3. Review: Contractor shall submit the Training Plan to the CM, who will then disseminate it for review to the Cx Team. Contractor shall incorporate comments and requirements resulting from the review and resubmit the Training Plan prior to conducting any training sessions.

E. Training Prerequisites: Equipment and Systems Training ("Training") shall not be conducted until the subject system or equipment has completed Start-Up Documentation requirements and Turn-Over. If the Contractor wishes to schedule both Turn-Over and Training on the same day/visit and if the systems are discovered to not be fully-functional at that time, Training shall be canceled and rescheduled.

F. Equipment and Systems Training – Description and Content
1. Description: Equipment and Systems Training events will typically occur over a period of time as systems and equipment are brought online and Turned-Over. Training shall cover proper operation, maintenance, repair, and diagnosis of the systems, equipment, and components installed by the Contractor. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. These sessions shall use the manufacturer's printed installation, operation and maintenance instruction material and shall include a review of these instructions emphasizing safe and proper operating requirements and preventative maintenance. Training shall follow handouts that list the key points in bullet form presentation-style or follow detailed written documentation. Training will not be approved unless it contains accompanying written documentation.
2. Equipment Covered: Training shall be provided for all major items of equipment within the scope of commissioning and per the Specifications.
3. Minimum Training Content: Equipment and Systems Training shall include as a minimum for each type of equipment:
   a. Presentation of the equipment within the context of this facility. Typically, the responsible subcontractor shall provide this introduction to the session. The
trainer shall review how the equipment serves this specific facility. Information shall include equipment amounts, numbers, capacities, sizes and locations and shall show the equipment in applicable system schematics.

b. Conceptual overview of how the equipment works;

c. Names, addresses, phone numbers, websites of sources for information, tools, spare parts, and other details for the equipment;

d. Details of the warranty or guarantee;

e. Intended sequences of operation in all modes of operation;

f. Limits of responsibility (example: unit-mounted controls vs. BAS);

g. Sources of utility support;

h. Routine operator tasks involving monitoring and operation, covering all modes of operation and mode switching as applicable;

i. Relevant health and safety practices/concerns;

j. Common problems and their diagnosis and repair;

k. Proper maintenance schedules, tasks and procedures with demonstrations;

l. Emergency response, documentation and recovery procedures.

4. Scheduling: These events shall be coordinated through and scheduled by the CxA, PSU and CM.

5. Attendees: Contractor shall insure that all appropriate subcontractors be present for these sessions. Any Cx Team member is eligible to attend. Required attendees include the applicable Contractors (Lead), CxA, and the Owner/Operator.

G. Final Systems Operation Training

1. Description: Final Systems Operation Training provides the Owner and Operators a training session on whole-building operation. It shall focus primarily on BAS control of building systems and operation and its impact on building performance. System interactions shall be presented and discussed (such as a combined air handler, chiller, boiler, and terminal unit system), along with a detailed presentation of the sequences of operation and their relationship to the BAS. This training shall be conducted by the BAC with assistance from the CxA, and shall be attended by the Owner, Operators, Contractor, Design Team, and by any other Cx Team members deemed necessary by the CxA or the Owner.

2. Coordination with BAS Training: Detailed BAS component training for the facility Operators shall be considered as part of Equipment and Systems Training. This training shall have been completed prior to Final Systems Operation Training.

3. Scheduling: Final Systems Operation Training shall be conducted after all FPTs have been successfully executed.

4. Attendees: Any Cx Team member is eligible to attend. Required attendees include the BAC (lead), CxA (assist), CM, mechanical contractor, A/E, and Owner/Operators.

1.22 CONTRACTOR DEVELOPMENT OF O&M DOCUMENTATION

A. Contractors are responsible for submitting manufacturer-developed O&M Manuals per the Contract Documents and for developing installation-specific O&M Documentation.

B. O&M Documentation: O&M Documentation is Contractor-developed documentation designed to address the needs of facilities personnel and customized for the context of the specific facility and installation. Contractors, subcontractors and vendors/factory representatives shall prepare, organize, author, and submit applicable O&M content. The foundation of O&M Documentation is manufacturer’s literature (O&M Manuals), with additional Contractor-developed content as specified below. O&M Documentation content is indexed/organized by equipment-type. If a Systems Manual is being developed, Contractor-developed content shall be coordinated with the CxA for inclusion into the Systems Manual.
C. O&M Documentation Content: Content for one system and all associated equipment must be organized and made in one submission. However systems may be submitted separately based on the progress of the project. Content shall be provided and indexed separately as ‘Operations Manual’ and ‘Maintenance Manual’ as specified below.

This Part shall be organized by Division then system/subsystem using a systems approach.

1. Contact Information: Provide contact cross-references to the Parties applicable to the system being described and contained in the main Contact Directory in Part 1.
2. Start-Up and Shutdown Procedures: Provide step-by-step instructions to bring systems from static to operational configurations and from operating to shutdown status. Installing Contractor or Vendor/Manufacturer shall author this specifically for this project.
3. Normal Operating Instructions: Provide a discussion of the normal operation and control of the system. Address operating norms (for example, temperatures, pressures and flow rates) expected at each zone or phase of the system. Supplement the discussion with control and wiring diagrams and data. Installing Contractor or Vendor/Manufacturer shall author this specifically for this project.
4. Emergency Operating Instructions: Provide emergency operating procedures in the event of equipment malfunctions. Provide shutdown instructions for fires, explosions, spills, or other contingencies. Installing Contractor or Vendor/Manufacturer shall author this specifically for this project. This content shall be in the context of the systems themselves and support the Emergency Operations manual to be created by the Owner.
5. Environmental Considerations: Provide a listing of the equipment that requires special operation, reporting, testing, analysis or inspection to comply with federal, state or local environmental laws. Examples of possible list items include backflow preventer inspections, underground storage tank testing, hazardous material or waste usage/storage documentation and air pollution control devices. For each item, include requirements for environmental operation, reporting, testing, analysis and inspection as well as references to respective implementing regulations, statutes or policies.
6. Equipment and System Training Documentation: Include documentation of training for applicable system. Include training agenda, all handouts and presentation materials/content. Reference existence and index of DVD or video tape recording.
7. Sequence of Operation/Control Schematic: Provide the written sequence of operation for the applicable system and the control schematic diagram. This information may be obtained from the A/E or design team members.
8. Maintenance Service Agreements: Provide copies of maintenance service agreements where there pertain to systems involving multiple components and devices as indexed in Part 3.
9. Test, Adjust and Balancing Reports: Insert the TAB Reports provided under Section 23 05 93 for the subject system.

D. Maintenance Manual

Organize this section first by discipline then by equipment number or ID.

1. Maintenance Index: Provide a summary table that indexes the equipment requiring maintenance and indicates the frequency each piece of equipment needs attention, and a reference to the number of the Procedure associated with that frequency. CM shall provide Contractors with an Excel spreadsheet that will be completed by each applicable subcontractor and returned to the CM for incorporation in the Systems Manual.
2. Maintenance Information: Maintenance Information for each indexed entry shall contain the following:
   a. Equipment Data Sheet: Provide a summary of key nameplate and performance data.
   b. Procedures: Provide a ‘Task Card’ or step-by-step procedures for each individual maintenance procedure for a given frequency identified on the Maintenance Index. Include detailed PM procedures, safety instructions and precautions including Lock Out/Tag Out precautions, required skill level, number of personnel needed, frequency, special tools needed, parts needed and estimated time required to
complete the task. These procedures shall be indexed in a manner approved by the Owner. These shall be provided as Microsoft Word files or scanned documents from the manufacturer’s O&M Manual in either PDF or JPG formats)

c. Field Test Reports: Provide Field Test Reports that apply to equipment associated with the system.
d. Troubleshooting Instructions: Provide detailed troubleshooting instructions indexed by common/expected symptoms. Alternatively, make specific reference to page in the manufacturer’s O&M Manual where this information is provided.
e. Extended Warranty Information: Include all warranties for products, equipment, components, and sub-components whose duration exceeds one year. Include warranties on components with the system they are contained within. Reference all specific operation and maintenance procedures that must be performed to keep the warranty valid.
f. Special Tools: Provide a listing of any special tools required for servicing, diagnosis, or repair. Alternatively, reference specific page in the manufacturer’s O&M Manual where this information is provided.
g. Supply Inventory Requirements: Provide a list of maintenance and repair supplies (e.g., spare parts, fuels and lubricants) required to ensure continued operation without unreasonable delays. Identify and list parts and supplies that have long purchase lead times. Alternatively, reference specific page in manufacturer’s O&M Manual that contains this information.
h. Sources of Spare Parts: Provide list or reference to recommended spare parts and contact information where spare parts can be obtained.
i. Lubrication Schedule: Provide a lubrication schedule indicating types, grades, and capacities of lubricants for specific temperature ranges and applications. Alternatively reference the specific page in the manual that contains this information.
j. Maintenance Service Agreements: Provide copies of maintenance service agreements where they pertain specifically to indexed equipment.
k. Manufacturer’s O&M Manual: Include manufacturer’s printed O&M information. These shall be provided in PDF format. If unavailable as PDF from the manufacturer, hardcopy manual shall be scanned and provided as a single file.
l. Application and Installation Instructions: Where applicable and separate from the O&M information, provide the Application and Installation Instructions that indicate how to correctly apply and install/setup the equipment.

E. O&M Documentation Format: Content authored, developed and compiled by the Contractor shall be available both electronically and hardcopy. Specific electronic format shall be coordinated with the CxA. Acceptable electronic formats shall allow for editing and commenting, and include Microsoft Word, Excel, PowerPoint, Access, and Visio; Portable Document Format (PDF), AutoCAD, graphics/photo formats such as JPG,

F. Mechanical Contractor O&M Documentation Submittal: The Division 22 and 23 Contractor shall compile and organize the content for all work of Divisions 22 and 23 and provide one organized submittal. Upon approval by the CxA, the content may be provided in multiple system and equipment-level submittals. Each submission shall be provided at least one month prior to the start of the Acceptance Period. This submittal will be reviewed by A/E, CxA, Owner, and CM within two weeks of the submission. Contractor shall incorporate comments and corrections and resubmit prior to the start of the Acceptance Period. Within two weeks of Functional Completion, the Division 22 and 23 Contractor shall provide the final version of all O&M Documentation information in one submittal.

G. Other Contractor O&M Documentation Submittals: Submittals by all other Contractors (other than Div 22 and 23 shall be provided per specifications within their respective Division of work.
H. Maintenance and Updates of O&M Documentation Content: Contractors shall maintain the applicable O&M Documentation content throughout the Warranty Period. All hard copies will be retained at the Owner’s facilities or electronically online at a web-based FTP or Internet site. Changes throughout the Warranty Period shall be fully coordinated with the CxA. Maintenance of O&M Documentation content shall include:
1. Changing any indicated settings, parameters, and other operational parameters that were changed by the Contractor during the Warranty Phase.
2. Changing any instructions as to procedures that needed to be changed during the Warranty Phase.
3. Changing the Record Schedules and/or Sequences of Operation if they were changed during the Warranty Phase.
4. Updating any O&M Documentation content if changed or updated by the manufacturer.

I. Electronic Copies: Electronic copies may be posted to the Portal. When a posting is made, emails shall be sent to the receiving Parties (and copied to any other interested Parties) stating that the submission has been posted. Posting needs only to be the current submission. Contractor shall maintain all versions of the submission and provide upon request. When electronic submissions are made on electronic media such as CDs, six copies of the electronic media shall be provided.

J. Paper-Based (Hard) Copies: The number of copies shall be as follows:
1. Initial construction phase submission shall include 6 copies. All will be returned within two weeks.
2. Pre-Acceptance Phase submission shall include 6 copies. All will be returned at the completion of Acceptance Testing.
3. Final Systems Manual content submission shall include 6 copies. All will remain at the Owner’s facilities from then on.
4. Modifications made to the information shall be made to all copies.

1.23 SYSTEMS MANUAL PREPARATION AND LOGISTICS

A. Definition: The Systems Manual is the final deliverable from the Cx process, and provides the information needed to understand, operate, and maintain the facility and its systems. It is typically developed by the CxA, but with content required to be provided by the design team and the Contractors. The Systems Manual expands the scope of standard O&M documentation to incorporate additional information developed through the Cx process. The Systems Manual should be the repository of all updates and corrections as they occur (even throughout Occupancy). It is narrative in nature and organized by system types and by area/usage of the facility (if applicable). Systems Manual content typically includes narrative descriptions of the facility and systems, sequences of operation, schematic diagrams, cuts from design drawings and equipment literature, photos, and manual start/stop and emergency operating procedures for important equipment.

B. Systems Manual Lead Developer Responsibilities: The lead developer of the Systems Manual for this project shall be the CxA. The lead developer is responsible for organizing and producing the Systems Manual and for managing the content and contributions from the Parties responsible for providing technical content. The Party responsible for each topic shall assemble, author, develop, coordinate, or otherwise produce the content for that topic as specified below and provide to the lead developer. Requirements as specified include requiring the applicable Contractors to author project-specific information in a consistent format in addition to submission of standard pre-printed manufacturer’s O&M and product information.

C. Systems Manual Contractor Responsibilities: Contractor, Subcontractors and Vendors/Factory Representatives shall prepare, organize and submit applicable content for the comprehensive and coordinated Systems Manual as specified below. Some of the material required from the
Contractors will need to be authored or customized specifically for this project and facility. Contractor content is indicated by “CM” who is responsible for consolidating the content and materials from the various individual Contractors. Content for one system and all associated equipment must be organized and made in one submission. However systems may be submitted separately based on the progress of the project. Each submission shall be indexed as a sub-entity to the overall Systems Manual submission.

D. Division 22 and 23 Contractor Responsibilities: The Division 22 and 23 Contractor shall compile and organize the content for all work of Divisions 22 and 23 and provide one organized submittal. Upon approval by the CA, the content may be provided in multiple system and equipment-level submittals. Each submission shall be provided at least one month prior to the start of the Acceptance Period. This submittal will be reviewed by A/E, CxA, Owner, and CM within two weeks of the submission. Contractor shall incorporate comments and corrections and resubmit prior to the start of the Acceptance Period.

E. Final Systems Manual Content Submittal: Within two weeks after Functional Completion, Contractors shall provide the final version of all Systems Manual information. Division 22 and 23 Contractor shall provide final version in one single submittal.

F. Maintenance and Updates of Systems Manual Content: Contractors shall maintain the applicable Systems Manual content throughout the Warranty Period. All hard copies will be retained at the Owner’s facilities or electronically online at a web-based FTP or Internet site. Changes throughout the Warranty Period shall be fully coordinated with the CxA. Maintenance of Systems Manual content shall include:
   1. Changing any indicated settings, parameters, and other operational parameters that were changed by the Contractor during the Warranty Phase.
   2. Changing any instructions as to procedures that needed to be changed during the Warranty Phase.
   3. Changing the Record Schedules and/or Sequences of Operation if they were changed during the Warranty Phase.
   4. Updating any Systems Manual content if changed or updated by the manufacturer.

   1. Electronic Version: The electronic version of the Systems Manual will be a series of files organized in subdirectories with a summary index with hyperlinks to the various documents and or references to separate CDs that contain the information. During authoring, sample format Microsoft Office documents (Word, Excel or Powerpoint) will be provided to be used by vendors and contractors to provide the custom-authored content to the lead developer for final compilation. Electronic copies of the product data shall be in PDF format. Drawings shall be in AutoCAD or PDF format.
   2. Electronic File Submissions. Electronic files of Systems Manual content may be posted to the project website. When a posting is made, emails shall be sent to the receiving Parties (and copied to any other interested Parties) stating that the submission has been posted. Posting should only include the current submission, although the Contractor shall maintain all versions of the submission and provide upon request. When electronic submissions are made on electronic media such as CDs, six copies of the electronic media shall be provided.
   3. Paper-Based (Hard) Copies: The number of copies shall be as follows:
      a. Initial construction phase submission shall include 6 copies. All will be returned within two weeks.
      b. Construction Phase submissions shall include 6 copies. All will be returned at the completion of Acceptance Testing.
      c. Final Systems Manual content submission shall include 6 copies. All will remain at the Owner’s facilities from that time forward.
      d. Modifications made to the information shall be made to all copies.
1.24 SYSTEMS MANUAL CONTENT AND ORGANIZATION

A. Systems Manual Scope: The Systems Manual format and content requirements shall be as follows. Documents developed or otherwise provided as specified in the Contract Documents should be used directly or referenced to the extent possible, including but not limited to OPR/BOD narratives, shop drawings, submittals, and O&M Manuals. Responsible parties are as indicated in square brackets; tasks not delineated by a responsible party are the responsibility of the lead developer.

B. Part 1 – Facility Information
   2. Contact Directory: Include the contact information for all contractors, subcontractors, vendors, manufacturers, and any other entity that has provided goods or services installed at the facility. Contact information should include name, website, address, phone numbers, and technical support phone numbers and email addresses.
   3. General Facility and System Description: A/E Describe the function of the facility. Detail the overall dimensions of the facility, number of floors, foundations type, expected number of occupants, and facility category code. List and generally describe all the facility systems listed in Part II - Primary Systems Information and any special building features (for example, cranes, elevators, and generators).
   4. Utility Connection and Cutoff Plans: A/E Provide utility site and floor plans that indicate the exterior and main interior connection and cutoff points for all utilities. Include enough information to enable someone unfamiliar with the facility to quickly locate the connection and cutoff points. Do not include items such as contour lines, elevations, and subsurface information on the site plans. Indicate the room number, panel number, circuit breaker, valve number, etc., of each connection and cutoff point, and what that connection or cutoff point controls. These plans are in addition to the floor plans.
   5. Warranty Information: CM Provide all warranties indexed in a logical order.

C. Part 2 - Primary Systems Operating Information
   This Part shall be organized by Division then system/subsystem using a systems approach. Part 2 contains system information, whereas Part 3 contains equipment information.
   1. System Description [A/E]: Provide a detailed discussion of the system composition and operation. Include technical details that are essential for an understanding of the system. A/E shall provide narratives to the CM who shall provide these to the major subcontractors for use in preparation of their required content. Also cross-reference O&M data contained in Part 4 and product data and submittals contained in Part 4.
   2. Contact Information [CM]: Provide contact cross-references to the Parties applicable to the system being described and contained in the main Contact Directory in Part 1.
   3. System Flow Diagrams [A/E]: Provide a flow diagram indicating system liquid, air (do not include ductwork) or gas flow during normal operations. Integrate all system components into the diagram. Note that a compilation of non-integrated flow diagrams for the individual system components is not acceptable.
   4. Diagrammatic Plans [A/E]: Provide floor plans indicating the location of equipment and configuration of the system installation. Include the configuration of associated piping or wiring, subordinating structural features to utility features.
   5. Start-Up and Shutdown Procedures [CM]: Provide step-by-step instructions to bring systems from static to operational configurations and from operating to shutdown status. Installing Contractor or Vendor/Manufacturer shall author this specifically for this project.
   6. Normal Operating Instructions [CM]: Provide a discussion of the normal operation and control of the system. Address operating norms (for example, temperatures, pressures and flow rates) expected at each zone or phase of the system. Supplement the discussion with control and wiring diagrams and data. Installing Contractor or Vendor/Manufacturer shall author this specifically for this project.
7. Emergency Operating Instructions [CM]: Provide emergency operating procedures in the event of equipment malfunctions. Provide shutdown instructions for fires, explosions, spills, or other contingencies. Installing Contractor or Vendor/Manufacturer shall author this specifically for this project. This content shall be in the context of the systems themselves and support the Emergency Operations manual to be created by the Owner.

8. Environmental Considerations [CM]: Provide a listing of the equipment that requires special operation, reporting, testing, analysis or inspection to comply with federal, state or local environmental laws. Examples of possible list items include backflow preventer inspections, underground storage tank testing, hazardous material or waste usage/storage documentation and air pollution control devices. For each item, include requirements for environmental operation, reporting, testing, analysis and inspection as well as references to respective implementing regulations, statutes or policies.

9. Equipment and System Training Documentation [CM]: Include documentation of training for applicable system. Include training agenda, all handouts and presentation materials/content. Reference existence and index of DVD or video tape recording.

10. Sequence of Operation/Control Schematic [A/E]: Provide the written sequence of operation for the applicable system and the control schematic diagram.

11. Maintenance Service Agreements [CM]: Provide copies of maintenance service agreements where there pertain to systems involving multiple components and devices as indexed in Part 3.

12. Test, Adjust and Balancing Reports [CM]: Insert the TAB Reports provided under Section 23 05 93 for the subject system.

D. Part 3 - Maintenance Manual

Organize this section first by discipline then by equipment number or ID.

1. Maintenance Index [CM]: Provide a summary table that indexes the equipment requiring maintenance and indicates the frequency each piece of equipment needs attention, and a reference to the number of the Procedure associated with that frequency. CM shall provide Contractors with an Excel spreadsheet that will be completed by each applicable subcontractor and returned to the CM for incorporation in the Systems Manual.

2. Maintenance Information [CM]: Maintenance Information for each indexed entry shall contain the following:
   a. Equipment Data Sheet: Provide a summary of key nameplate and performance data.
   b. Procedures: Provide a ‘Task Card’ or step-by-step procedures for each individual maintenance procedure for a given frequency identified on the Maintenance Index. Include detailed PM procedures, safety instructions and precautions including Lock Out/Tag Out precautions, required skill level, number of personnel needed, frequency, special tools needed, parts needed and estimated time required to complete the task. These procedures shall be indexed in a manner approved by the Owner. These shall be provided as Microsoft Word files or scanned documents from the manufacturer’s O&M Manual in either PDF or JPG formats.
   c. Field Test Reports: Provide any Field Test Reports that apply to equipment associated with the system.
   d. Troubleshooting Instructions: Provide detailed troubleshooting instructions indexed by common/expected symptoms. Alternatively, make specific reference to page in the manufacturer’s O&M Manual where this information is provided.
   e. Extended Warranty Information: Include all warranties for products, equipment, components, and sub-components whose duration exceeds one year. Include warranties on components with the system they are contained within. Reference all specific operation and maintenance procedures that must be performed to keep the warranty valid.
   f. Special Tools: Provide a listing of any special tools required for servicing, diagnosis, or repair. Alternatively, reference specific page in the manufacturer’s O&M Manual where this information is provided.
g. Supply Inventory Requirements: Provide a list of maintenance and repair supplies (e.g., spare parts, fuels and lubricants) required to ensure continued operation without unreasonable delays. Identify and list parts and supplies that have long purchase lead times. Alternatively, reference specific page in manufacturer’s O&M Manual that contains this information.

h. Sources of Spare Parts: Include reference to contact information where spare parts can be obtained.

i. Lubrication Schedule: Provide a lubrication schedule indicating types, grades, and capacities of lubricants for specific temperature ranges and applications. Alternatively reference the specific page in the manual that contains this information.

j. Maintenance Service Agreements: Provide copies of maintenance service agreements where they pertain specifically to indexed equipment.

k. Manufacturer’s O&M Manual: Include manufacturer’s printed O&M information. These shall be provided in PDF format. If unavailable as PDF from the manufacturer, hardcopy manual shall be scanned and provided as a single file.

l. Application and Installation Instructions: Where applicable and separate from the O&M information, provide the Application and Installation Instructions that indicate how to correctly apply and install/setup the equipment.

E. Part 4 - Construction Documentation

1. Record Drawings [A/E]: Provide an index of all Record Drawings with drawing number, title, and electronic file name(s) including electronically referenced drawings.

2. Record Specifications [A/E]: Provide a detailed index of the Record Specification. Include sections and major items in the specification all indexed to the appropriate page number.

3. Approved Product Data and Shop Drawings [A/E]
   a. Provide an index of all product data and shop drawings. This shall list all equipment with the associated submittal number.
   b. Organize and compile only APPROVED product data and shop drawings. Providing these in a filing format is acceptable provided all files are identified and organized for easy access.
   c. This information is required for this Part in its entirety regardless of inclusion in any other sections of the Systems Manual.

4. Commissioning Record [CxA]: Provide complete Cx records including all Start-Up Documentation and Functional Performance Test documentation.


1. Preventative Maintenance Specification [CxA]: Specification for day to day maintenance of the facility, including operating log requirement, reports, and preventative maintenance tasks for each system, including recommended inspections, and tests.

2. Recommissioning Test Log [CxA]: Blank testing plan for future use in recommissioning.

1.25 COMMISSIONING PENALTIES

A. Functional Performance Testing (FPT) Failures: Penalties resulting from FPT failures are specified in Section 01 91 10.

1.26 PHASING PLAN

A. If Contractor intends to start, run, or occupy portions of systems in phases, Contractor shall submit a Phasing Plan for phasing in areas/portions of systems that will be connected subsequent to the initial portions. Phasing Plan shall specifically address:
   1. Pipe and Duct Cleaning: Indicate the configurations and protocols for isolating subsequent regions and then protecting the preceding regions when the subsequent region is cleaned/flushed and connected.
2. Pipe Disinfection: Indicate the plan for disinfecting each region of potable water or medical gas pipe that requires disinfection. Indicate how the preceding regions of the system will be protected when connecting subsequent regions.

3. Piping Certification/Testing: Indicate the plan for certifying each region of pipe that requires certification and or testing such as laboratory gases, medical gases, and RO/DI water (testing for water quality). Indicate how the preceding regions of the system will be protected when connecting subsequent regions. Indicate how you will verify that the certification/test results on the previous systems have not been invalidated.

4. System Modifications: Indicate the protocols for making subsequent changes to the systems of pipe and duct when the systems have already been cleaned, flushed, pressure tested, disinfected, and certified.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment used in the Cx process shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.

B. Standard Testing Instrumentation: Standard testing instrumentation normally used for performance assessment and diagnosis will be provided by the CxA. Refer to Sections 23 08 00 and 26 08 00 for a list of applicable test equipment.

C. Special Tools: Special equipment, tools and instruments (only available from a vendor, and specific to a piece of equipment) that are required for testing equipment in accordance with these Contract Documents shall be included in the base bid price to the Contractor and turned over to the Owner upon completion of the project.

2.2 WEB-BASED COMMISSIONING PORTAL

A. General: The Cx Portal ('Portal') is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CxA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process. The Portal uses a hierarchical object tree to represent building systems, components and devices. From this object tree, one can access associated information at and below the applicable level. All applicable elements of information are associated with the object tree. The Portal facilitates either completing information directly via the software or by printing forms to fill out in the field.

B. Participation: All general and major subcontractors participating in the Cx process shall participate in the use of the Portal to document the Cx procedures.

C. Requirements for Use: Options for accessing and interfacing with the Cx Portal are as follows:

1. Print, Test, and File: Using this approach, Contractors simply go online to the Portal using a web browser, print checklists and tests as needed, fill them out in the field, and enter the results back into the Portal database when completed.

2. Online in the Field: The applicable documents can be accessed and filled out live and online if the Contractor has the means to access the Internet while working in the field using a local Wi-Fi network or wireless air card.

3. Database Client: At the Contractor's option, the CxA can provide the Contractor with a software tool that will allow the Contractor to download electronic test database files from
the Portal, work on the database files in the field electronically (but offline), and later synchronize their entries with the master database on the Portal.

D. Portal Training: Included in the contract are two Contractors training sessions given by the CxA (one scheduled near the Construction Phase Cx Kickoff Meeting and one scheduled prior to the first equipment Start-Up). Contractors shall send at least one representative to at least one training session. Each Contractor is entitled to two hours phone technical support beyond training sessions.

PART 3 - EXECUTION

3.1 START-UP STANDARD OF CARE

A. Procedures that establish a minimum Standard-of-Care for the start-up, checkout and testing of applicable equipment are specified in the individual technical specifications and in Section 01 91 00 and Sections 23 08 00 and 26 08 00. Contractor shall apply this Standard-of-Care and document per the Cx requirements.

3.2 FUNCTIONAL PERFORMANCE TEST EXECUTION

A. Functional Performance Testing procedures are specified in Section 01 91 10. Contractor shall participate in the development and approval of the testing procedures, as well as participate as required in the initial sample of tests as indicated herein.

3.3 ACTION LIST

A. CxA shall maintain an Action List tracking Action Items (required information, identified deficiencies, work required, etc.) that relate to the Cx process. Each item shall be tracked with the initiator, the Parties responsible, due date, the date of closure, and a description of the resolution. Each item shall be categorized for sorting and tracking and for documentation on applicable forms.

B. CxA will disseminate this list as appropriate to keep all Parties informed.

C. All Parties indicated as responsible for an Action Item shall respond. Parties participating using the Portal shall respond via the Portal. Other Parties may respond by separate email.

D. The originator of an Action Item shall close it and record the resolution. Closing an Action Item amounts to entering the date on which it was addressed.

3.4 SEQUENCING ILLUSTRATION

A. A simplified schematic diagram of the precedents involved in the Cx process is provided below. The diagram is generally applicable on a system-by-system basis. Different systems or areas of the building may be phased or sequenced such that different systems are at different points in the Cx process. The diagram indicates tasks for the Contractor, the A/E and the CxA. Tasks for each are indicated vertically below their name. The individual tasks are as defined herein. Management protocols are also covered herein.

<This area intentionally left blank. See following page for Commissioning Workflow diagram>
CONTRACTOR

A/E

CXA

CONSTRUCTION PHASE

Prepare Shop Drawings and Product Data

Review

Resubmit

Appr

Yes

Review

Resubmit

Appr

Prepare checklists

Resubmit/Restart

Yes

Warranty Phase

Acceptance Phase

Opr Tst

Appr

FPT

Fail

Test

Pass = Functional Completion

Warranty Phase

Prepare Shop Drawings and Product Data

Review

Resubmit

Appr

Prepare checklists

Resubmit/Restart

Yes

Warranty Phase

Acceptance Phase

Opr Tst

Appr

FPT

Fail

Training

FPT

Training

Fail

Test

Sequencing Illustration

END OF SECTION 019100
PART 1 - GENERAL

1.1 WORK INCLUDED

A. Functional Performance Testing (FPT; ‘testing’) of systems.
B. Documentation of FPTs.
C. Acceptance criteria.

1.2 SCOPE

A. This section describes the Functional Performance Testing (FPT) process, procedures, and requirements. It is intended to illustrate the Contractor’s requirements for assisting the Commissioning Authority (CxA) with the Functional Performance Testing of systems, and (ii) to demonstrate the level at which systems and equipment will be tested prior to being deemed ‘Acceptable’ to the Owner.

B. The CxA will prepare itemized and detailed FPT plans and procedures that:
   1. Specify individual tests and procedures that meet the general requirements of the Cx Plan and commissioning (Cx) process;
   2. Serve to document and record the testing procedures and the results of the tests.

C. The Contractor shall provide technical input to the CxA as needed during the development of the final project FPTs.

D. Example (referred herein to as ‘generic’) FPTs are provided as illustration to the Contractor of the level of detail to which FPTs will be conducted.

1.3 RELATED WORK AND DOCUMENTS

A. The Cx process references many related Sections, particularly Section 01 91 00 - General Commissioning. It is important for all Contractors subject to the Cx process to be familiar with Section 01 91 00.

B. Refer to Section 01 91 00 for a complete list of Sections on Related Work.

1.4 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 01 91 00 for a complete list of Definitions and Abbreviations. This paragraph includes a comprehensive list of acronyms describing the various required Parties referred to in the Section for individual FPTs.

1.5 REFERENCE STANDARDS

A. Refer to Section 01 91 00 for a complete list of Reference Standards.
1.6 FUNCTIONAL PERFORMANCE TESTING

A. Objectives and Scope: Systems shall be tested to ensure proper operation through all modes of operation including normal expected operation, maintenance operation as well as proper response to system and component failures that are considered abnormal operation as indicated below.

1. Normal Operation: Each system shall be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. These series of tests will demonstrate that the systems and equipment operate throughout typical operation including normal adjusting, cleaning, media replacement, and maintenance.

2. Abnormal Operation: Test each system to simulate possible abnormal conditions and verify proper responses to such modes and conditions as power failure, equipment and component failure, freeze condition, deviation of operating parameters outside of normal, no flow, supporting utility failure, human error, etc. Abnormal operation tests shall demonstrate proper and safe response to the subject systems and the other systems that it affects or integrates with. These tests shall also demonstrate proper enunciation of abnormal conditions to quickly and effectively notify users and operators of such condition. Specific modes required in this project are given in this section and any other sections where test requirements are found.

B. Development of Test Procedures: CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Prior to execution, the CxA shall provide a copy of the test procedures to the Contractor who shall review the tests for feasibility, safety, equipment and warranty protection, and scope. The CxA will also submit the tests to the A/E for review.

1. Contractor shall review the FPTs in detail and approve them.

2. The CxA shall review Owner-contracted testing, factory testing, or required Owner acceptance tests for which the CxA is not responsible to oversee. Review shall include content, scope, and documentation format, and shall determine what further testing or format changes may be required. Redundancy of testing shall be minimized.

3. The purpose of any given specific FPT is to verify and document compliance with the stated criteria of acceptance.

C. Scheduling: CM shall schedule the Functional Performance Testing after system 'Turn-Over' occurs (Turn-Over is the official Contractor notification that systems have completed Start-Up and are ready for testing and submittal and review of all the required submittals has occurred). To the extent practical, tests shall be scheduled to allow efficient and contiguous testing of inter-related systems and equipment.

D. Phasing: Non-interdependent segments of the project testing can be phased. Phasing of this project is described below

E. Participation: CxA will direct and conduct Functional Performance Tests after Start-Up Documentation of systems and equipment has been reviewed and accepted and system ‘Turn-Over’ occurs. Conceptual procedures for the Functional Performance Testing are outlined elsewhere in this Section. CxA will execute the FPTs unless otherwise specified. Contractor shall assist as described above with manipulation of the systems or equipment, provision of supporting equipment or materials (lifts, ladders, specialty test equipment, safety equipment),
and on-the-spot remediation of minor identified deficiencies whenever possible. Required participation is outlined in the generic FPTs provided elsewhere in this Section.

1. Any Cx Team member may attend any FPT. Required Parties are as described below.

2. Typically, multiple parties are required for any given test, yet participation for any given party is only required for the respective portion of the test for which the party is responsible. The CxA will notify each trade of the testing which they must participate. Only those notified Contractors, which participate in the testing, will be credited for the hours against their FPT allotment.

3. No Party involved with the project is prohibited from participation in or witnessing of any tests. Any Contractor may elect to witness all tests on their systems even if their involvement is not directly required (for instance, BAC involvement is sometimes required on the first few of a sample and not on the entire sample).

4. The maximum required time for contractor FPT participation (in hours) is indicated below, by trade. Each category of support is to be provided by the contractor responsible for the installation of the system (e.g., the fire alarm support is to be provided by the FAC). Additional time required by the Contractor due to incompleteness of the system, failure of tests, or failure of sampling criteria shall be at the contractors expense, with no additional costs to the Owner. Mechanical (HVAC) FPT Support – 60 hours.
   a. Mechanical (Plumbing) FPT Support – 30 hours.
   b. Building Automation System FPT Support – 120 hours
   c. Electrical FPT Support – 70 hours
d. Fire Protection FPT Support - 8 hours.
e. Fire Alarm FPT Support – 16 hours.
f. TAB FPT Support – See section 230593, Testing Adjusting, and Balancing for Systems Verification requirements
g. Security System FPT Support – 16 hour

5. The CxA will track the Contractor’s FPT participation based on 4-hour segments of work, except as noted below.

F. Detailed FPT Development and Contractor Review: CxA will prepare detailed and itemized testing procedures to define and document the FPT. These will be typically be developed during the Construction Phase and completed during the Acceptance Phase. The CxA shall submit these procedures to the Contractor for review. Contractor shall indicate all required limitations, safety procedures, maximum thresholds, and any other parameters during the FPT development. Contractor shall be responsible for any damage to the equipment caused by Functional Performance Testing done per the procedures and within the limitations of the approved procedures.

G. Completeness: All systems must be completed and ready for FPT. All Start-Up Documentation, factory-authorized field testing, independent testing agency tests, and TAB procedures must be complete and the control systems must be tested and started for the respective system or component.

H. Test Documentation: CxA will conduct tests, and/or witness tests as applicable. CxA will record all test results on the forms developed for the testing. CxA will ‘Pass’ or ‘Fail’ the testing and record the date and time of the test. Deficiencies shall clearly be indicated when the test is failed. When all related testing is completed successfully, CxA shall recommend acceptance of the system or component.

I. Deficiencies and Retesting: When deficiencies are identified during testing, depending on their extent or magnitude, they can be corrected during the test and the testing can continue to successful completion. More significant deficiencies will require failure of the test and re-testing. Deficiencies of this magnitude will result in an Action Item on the Action List. The resolution of the deficiency will then subsequently be tracked by the CxA via the Action List. All tests shall be repeated until successful completion. Refer to more specific provisions below.
J. Sampling: Some types of identical equipment (such as terminal devices) will be tested using a sampling strategy. The sample percentage is indicated in the generic FPT provided elsewhere in this Section.

K. Max Failure Limit and Sample Percentages: A ‘Maximum Failure Limit’ is indicated along with the ‘Sampling Percentages’. The Max Failure Limit indicates the maximum percentage of the tested devices that may have any test that fails before an entirely new sample must be tested. This is based on the concept that if many failures occur, it is a result of inadequate start-up by the Contractor. When the maximum number of failures is reached, testing on that sample will be terminated and re-testing will be scheduled.
   1. If no Max Failure Limit is indicated, all tested samples must pass (Max Failure Limit = 0%).
   2. Where sample tests involve multiple systems (i.e., checking strainers on different hydronic systems), the Maximum Failure Limit will apply per system.
   3. The responsible Contractors shall pay the CxA cost of that sample test, and redo the start-up/TAB for the applicable devices/systems.
   4. All work necessitated by sample failures shall be at no cost to the Owner.

L. Opposite Season Testing: Testing procedures shall be repeated and/or conducted as necessary during appropriate seasons. Opposite Season testing will be required where scheduling prohibits thorough testing in all modes of operation. Air handler and central heating system testing for heating-related modes of operation and control loops shall be tested during outside air temperatures below [35°F].

M. Approval. The CxA passes each test and subsequently recommends approval to Owner who reviews and approves the FPT.

1.7 COORDINATION BETWEEN TESTING PARTIES

A. Factory Start-Ups: For many systems and equipment, Factory Start-Ups are specified. These Factory Start-Ups will be reviewed and checked during Functional Performance Testing. All costs associated with the Factory Start-Ups are included with the bid unless otherwise noted. Contractor shall make notification of when Factory Start-Ups are occurring and coordinate these with witnessing Parties. The CxA and other Cx Team members may witness Factory Start-Ups at their discretion. Aspects of Functional Performance Testing accomplished during the Factory Start-Ups may be accomplished and approved by the CxA if they meet the intent of the FPT.

B. Independent Testing Agencies: For systems where Independent Testing Agencies are specified, the cost of this testing shall be included with the bid unless otherwise noted. Much of the testing performed by Independent Testing Agencies will cover aspects required in the Start-Up Documentation and Functional Performance Tests.
   1. Contractor and testing agencies shall coordinate with the CxA so that the CxA can witness the testing and approve the applicable aspects of the FPTs.
   2. The CxA may in some cases independently spot-check work of the testing agencies if the tests were not witnessed. However, it is not the intent for the CxA to re-accomplish testing by others that is specified in the construction specifications. For instance, much of the testing requirements for the electrical systems will be performed by the independent electrical testing agency provided under the bid. The CxA shall witness the indicated sample of the testing and record the results in the record of Functional Performance Tests.
   3. Contractor is responsible for coordinating the efforts of testing agency with that of the Cx process. Documentation shall be contiguous and seamless and duplication should be avoided. Testing agencies shall complete the documentation of the Cx process as required.
C. Specialized Testing by Contractor: Where Specialized Testing is specified in the technical
specifications, the Contractor, subcontractor, vendor, or factory representative as applicable
shall conduct the Specialized Testing and provide all specialized instrumentation and
equipment. CxA and other Cx Team members may witness tests at their discretion. The CxA
may in some cases independently spot-check the results of the tests if the tests were not
witnessed. However, it is not the intent for the CxA to re-accomplish testing that is specified in
the construction specifications. All Specialized Testing procedures shall be integrated with the
Cx process and all documentation shall be coordinated and integrated with the documentation
of the Cx process. Examples of Specialized Testing include but are not limited to:
1. Acceptance testing of the fire alarm system
2. Fire suppression system hydraulic tests
3. Electrical system testing per NETA

1.8 FPT ACCEPTANCE CRITERIA

A. The Acceptance Criteria shall be as follows unless more specifically indicated within individual
tests. CxA may exercise professional judgment to relax requirements and pass tests and
recommend approval when appropriate.
1. Capacity: Capacity and/or equipment performance will generally be as specified ±5%.
2. Efficiency: Efficiency where specifically indicated in the documents will be ±5%. When
inferred from manufacturer’s catalogue data, criteria will be ±10%.
3. Balancing: Balancing-related criteria will be ±5% for water and ±10% for air.
4. Accuracy: Accuracy/repeatability on sensing devices will be as specified for the device.
CxA and TAB will use calibrated gages for independent validation and use judgment in
passing or failing the devices. In many cases, the coordination of multiple related
sensors is more important than absolute accuracy.
5. Controls: Control feedback loop response and setpoint deviation criteria will be as
specified in Section 25 08 00.
6. Sequences: HVAC sequence-related criteria will be as explicitly specified in the
documents and as interpreted by the CxA. Code required sequencing shall be per the
applicable code.
7. System sequences shall be as required by the approved shop drawings.
8. Motor Phase Imbalance: Shall be no more than 2% (Amps and Volts).
9. Noise Levels:
   a. Occupied Spaces: As indicated in the Owner’s Project Requirements or Basis of
   Design (OPR/BOD) document. Otherwise, noise level shall be as recommended
   in the most current version of the ASHRAE Handbooks for the applicable
   occupancy.
   b. At limits of the enterprise or facility: As required by current local ordinances.
10. Indoor Environmental Parameters (T, RH, CO2, VOC): Shall be as indicated in the Basis
    of Design document. Otherwise, as recommended in the most current version of the
    ASHRAE Handbooks for the applicable occupancy.
11. Air Pressurization: As indicated in the OPR/BOD document. Otherwise, as indicated in
    the most current version of the ASHRAE Handbooks for the applicable occupancy.
    Smoke/shaft pressurization shall be as required by NFPA to maintain maximum door
    opening forces and to restrict the passage of smoke.
12. Indoor Lighting Levels: As indicated in the OPR/BOD document. Otherwise, as
    recommended in the most current version of the IES Handbooks for the applicable
    occupancy.
13. Electrical Systems: Shall be in accordance with manufacturer’s recommendations of
    individual components and devices, NFPA 70B and International Electrical Testing
    Association (NETA) testing specifications NETA ATS-Latest Version.
14. Inter-system interfaces and coordination: As specified and generally to ensure safe,
    reliable, and robust operation.
PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance within the tolerances specified. All equipment shall be calibrated according to the manufacturer’s recommended intervals. Calibration tags shall be affixed or certificates readily available. Supplier of instrumentation shall submit the calibration certificates along with the start up documentation.

B. Standard Testing Instrumentation: Standard instrumentation normally used for performance assessment and diagnosis will be provided by the CxA for tests being conducted by CxA. All other instrumentation shall be provided by the Contractor. The instrumentation to be provided by the CxA includes:
1. Electronic manometer (for air and flow hood)
2. Electronic manometer (for water)
3. Temperature instruments and gauges
4. Humidity instruments and gauges
5. CO2 instrument
6. Sound meter
7. Light level meter
8. Electronic multimeter
9. Power analyzer (including power factor and THD)
10. Receptacle tester
11. Tachometer
12. Belt tensioner
13. Ultrasonic flow meter
14. Vibration meter capable of measuring peak-to-peak acceleration

C. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and provided to the Owner.

D. Provide a temporary license to software needed to access the BAS at both the terminal equipment and on the primary LAN/at primary controllers. Provide all configuration utilities needed to read all parameters and set up terminal boxes. Provide temporary graphic interface software license for use during the Acceptance Phase.

PART 3 - FUNCTIONAL PERFORMANCE TESTS (SYSTEMS AND EQUIPMENT RELATED)

3.1 PREREQUISITES

A. All equipment, components, and devices applicable to the FPT must be started and operational and systems must be ‘Turned-Over’ to the Cx Team. This includes completion and of Start-Up Documentation, pressure testing of equipment, duct, piping; flushing/cleaning of applicable systems; completed labeling and identification; completed insulation of applicable systems; and all other requirements for placing system into dynamic operation.

B. Unless specifically agreed to by the Owner and CxA, all support systems shall be complete prior to FPT. For instance, an air handler will require that:
1. The electrical system serving it is completed and tested;
2. The hydronic systems serving it have been pressure tested, flushed, and functional performance tested;
3. Balancing has been accomplished on the air and water sides;
4. The control systems have been started and calibrated.
C. The CxA shall determine the optimal sequence of testing.

3.2 FUNCTIONAL TESTING PROCESS

A. Functional Performance Testing (‘Functional Testing’) on any given system shall typically begin with testing device-level elements such as sensors and actuators; progress to component-level assemblies of devices; then to system-level, then to inter-system level, then to building-level.

B. Functional Testing of systems shall generally proceed from the utilities to the central systems, to the distribution systems, to the zone terminal units and services. CxA shall plan this process and communicate it through a precedent diagram (in Gantt or Pert format). Construction Manager shall reflect that process in the Construction Schedule. Subcontractors shall perform work in accordance with the schedule.

3.3 COMMON ELEMENTS FOR ALL SYSTEMS

A. Required submittal documentation shall be present and located convenient to testing area. Validate that all required documentation has been submitted and is per the contract requirements.

B. Contractor shall provide the completed Start-Up Documentation and shall follow Turn-Over procedures as specified in Section 01 91 00. CxA shall review the Start-Up Documentation and spot-check the installation prior to or at the beginning of the FPT.

C. Contractor shall demonstrate that access is sufficient to perform required maintenance.

D. BAS trends shall have been established as required in the documents. These shall be available for review prior to or during the FPT.

E. All dynamic systems powered by electricity shall be tested to simulate a power outage to ensure proper sequencing. Those on emergency power or uninterruptible power shall be tested on all sources.

F. Capacities and adjusted/balanced conditions as applicable shall be subject to check.

G. Sequencing Verification: All modes of operation and actions shall be verified for equipment/system samples.

H. System and equipment configurations shall be compared against the contract documents.

I. Verify functions (such as heating and cooling) are coordinated and do not overlap or ‘fight’.

J. All adjusted, balanced, controlled systems shall be assessed to determine the optimal setting for the system as applicable. The optimal settings should be determined to establish reliable, efficient, safe and stable operation.

K. BAS or Local Panel Dynamic Graphics: The graphic displays for all components, systems, and areas required to be represented by a BAS graphic shall be checked for adequacy and accuracy. Furthermore, when setpoints or other parameters are required to be adjustable, CxA shall verify that they can be adjusted directly from the graphic screen.

L. Emergency power tests for mechanical systems will be conducted in concert with the testing of the emergency power systems. Mechanical contractor shall be available for the power outage
test to test mechanical systems under a power outage. This is in addition to the requirements specified for the mechanical system.

M. Where system and zones are designed for various modes of operations, test representative systems in all modes of operation. This includes:
   1. Seasonal Modes
   2. Sequencing Modes
   3. Emergency Modes

END OF SECTION 019110
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- Prevailing Minimum Wage Determination - University Park
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## SECTION E - LIST OF DRAWINGS [C]

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## SECTION H - SCOPE OF WORK [C]

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## SECTION H1 - GENERAL SCOPE OF WORK (APPLICABLE TO ALL CONTRACTS)

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## SECTION H2 - PRELIMINARY SCHEDULE

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## SECTION H4 - GEOTECHNICAL REPORT, MARCH 31, 2009

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## SECTION H5 - BIM PROCESS - COORDINATION GUIDELINES [C]

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### SECTION H6 - THE PENNSYLVANIA STATE UNIVERSITY, DEPARTMENT OF ENVIRONMENTAL HEALTH AND SAFETY: ASBESTOS CONTAINING MATERIAL REMOVAL PERFORMANCE SPECIFICATION

### SECTION H7 - MASSARO CM SERVICES, LLC PREQUALIFICATION FORM

**DIVISION 1 - EXISTING CONDITIONS**

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**VOLUME 2**

**DIVISION 2 - EXISTING CONDITIONS**

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**DIVISION 3 – CONCRETE**

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**DIVISION 9 - FINISHES**

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**DIVISION 11 – EQUIPMENT**

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**DIVISION 12 – FURNISHINGS**

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**DIVISION 13 – SPECIAL CONSTRUCTION - NOT USED**
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| 14 20 00 | ELEVATORS |  |  |

## VOLUME 3

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| 21 05 17 | SLEEVES & SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING |  |  |
| 21 05 18 | ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING |  |  |
| 21 12 00 | FIRE-SUPPRESSION STANDPIPES |  |  |
| 21 13 13 | WET-PIPE SPRINKLER SYSTEMS [C] |  |  |

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| 22 05 13 | COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIP. |  |  |
| 22 05 16 | EXPANSION LOOPS FOR PLUMBING PIPING |  |  |
| 22 05 17 | SLEEVES & SLEEVE SEALS FOR PLUMBING PIPING |  |  |
| 22 05 18 | ESCUTCHEONS FOR PLUMBING PIPING |  |  |
| 22 05 19 | METERS AND GAGES FOR PLUMBING PIPING |  |  |
| 22 05 23 | GENERAL-DUTY VALVES FOR PLUMBING PIPING |  |  |
| 22 05 29 | HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT |  |  |
| 22 07 19 | PLUMBING PIPING AND EQUIPMENT INSULATION |  |  |
| 22 11 16 | DOMESTIC WATER PIPING |  |  |
| 22 11 19 | DOMESTIC WATER PIPING SPECIALTIES |  |  |
| 22 11 23 | DOMESTIC WATER PUMPS |  |  |
| 22 13 16 | SANITARY WASTE AND VENT PIPING |  |  |
| 22 13 19 | SANITARY WASTE PIPING SPECIALTIES |  |  |
| 22 14 13 | FACILITY STORM DRAINAGE PIPING |  |  |
| 22 14 23 | STORM DRAINAGE PIPING SPECIALTIES |  |  |
| 22 14 29 | SUMP PUMPS [C] |  |  |
| 22 15 13 | GENERAL-SERVICE COMPRESSED-AIR PIPING |  |  |
| 22 15 19 | GENERAL-SERVICE PACKAGED AIR COMPRESSORS AND RECEIVERS |  |  |
| 22 35 00 | DOMESTIC-WATER HEAT EXCHANGERS |  |  |
| 22 40 00 | PLUMBING FIXTURES |  |  |
| 22 47 16 | PRESSURE WATER COOLERS |  |  |
| 22 52 00 | WATER FEATURE MECHANICAL SYSTEM |  |  |

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<p>| 23 05 13 | COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT |  |  |
| 23 05 14 | VARIABLE-FREQUENCY MOTOR CONTROLLERS FOR HVAC EQUIPMENT [C] |  |  |</p>
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DIVISION 25 -- CONTROLS

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SECTION 02 41 00 – SITE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The abandonment and removal work, as specified herein, is not intended to be performed as a wrecking operation but as preparatory work relative to the performance of the various construction operations of the Project.
   1. In general, the extent of the removal work is as indicated on the Drawings.
   2. Demolition and removal of certain in-line structures and pipe sewers.
   3. Plugging existing facilities.
   4. Filling existing facilities.
   5. Demolition and removal of valves and valve boxes.
   6. Removal of existing hydrants, water fountains, and valves.
   7. Removal of existing water services.
   8. Removal of existing electric service and ductbank including vaults, handholes, transformers etc.
   9. Removal of existing telephone service and ductbank including handholes, vaults, etc.
   10. Clearing and grubbing.
   11. Removing existing above-grade improvements.
   12. Removing existing below-grade improvements.

B. Work shall be conducted in accordance with the General Conditions, Supplementary Conditions, Division 1, and the requirements of this Section.

1.2 RELATED SECTIONS

1. Section 33 01 01 – Maintenance and Support of Existing Utilities.
2. Section 31 20 00 – Earth Moving.
3. Section 31 22 00 – Grading.
4. Section 31 22 19 – Finish Grading.
5. Section 31 23 33.13 – Trenching for Site Utilities.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM C 32, Specification for Sewer and Manhole Brick (made from Clay or Shale).
   2. ASTM C 33, Specification for Concrete Aggregates.
   4. ASTM C 478, Specification for Precast Reinforced Concrete Manhole Sections.

B. Commonwealth of Pennsylvania Department of Transportation (PENNDOT), Specifications Publication 408, as supplemented.
   1. PENNDOT Section 703.3 Select Granular Material (2RC).

C. National Fire Protection Association (NFPA):

1.4 QUALITY ASSURANCE

A. Experience: Demolition contractor shall demonstrate a minimum of five years experience on similar projects.
B. Regulatory Requirements:
2. 29 CFR 1910 – Occupational Safety and Health Standards.

C. Other Requirements: Comply with the proposed Health and Safety Plan and Work Plan.

D. Safety Meetings: Conduct daily safety meetings.

1.5 SUBMITTALS

A. Documentation
1. Copy of request to utility companies owning or agency controlling services and appurtenances affected by demolition work for discontinuance of services or relocation of services. Submit copies to the owner.

B. Work Plan of proposed procedures for the demolition and removal work. Include a sequence of operations, equipment to be used and name and address of all proposed disposal and recycling facilities.

1.6 PROJECT CONDITIONS

A. Existing Conditions: The information presented on the Drawings is based on visual field examination of the site and review of existing record documents. While the information provided is believed to be correct, no assurance is implied relative to its total completeness or accuracy. Report discrepancies to the Construction Manager before disturbing existing installations.
1. The Drawings are intended to indicate the general nature of the demolition work required. Every facility appurtenant to those items designated for removal may not be indicated. Field verify dimensions, quantity, type material, location, means of anchorages and support, interconnection with other facilities, and other pertinent characteristics of facilities which shall be removed or demolished to accommodate new facilities.
2. The Contractor hereby distinctly agrees that neither the Owner nor the Professional is responsible for the correctness or sufficiency of the information given and after the Contractor’s own Site Investigation:
   a. Shall have no claim for delay or extra compensation or damage against the Owner or the professional on account of the information given.
   b. Shall have no claim for relief from any obligation or responsibility under the Contract with respect to the above stated stipulations.

B. Protection: Exercise care during demolition and removal work to confine demolition operations to facilities as indicated on the Drawings. Physical means and methods used for protection are discretionary; however, assume complete responsibility for replacement and restitution work of whatever nature and at no expense to the Owner.
1. Additionally, if public safety is endangered during progress of demolition work, provide adequate protective measures to protect public pedestrian and vehicular traffic on streets and walkways.
2. Signs, signals, and barricades to conform to requirements of Federal, State, and local laws, rules, regulations, precautions, orders, and decrees.

C. Protection of Existing Improvements: Provide protections necessary to prevent damage to existing improvements indicated to remain in place.

D. Protect improvements of Owner’s property.
E. Restore damaged improvements to their original condition, as acceptable to property Owners and including soil and debris tracked onto existing paving.

F. Traffic: Conduct site-clearing operations to ensure minimum interference with parking, roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, drive, walks, or other occupied or used facilities without permission from the Owner or authorities having jurisdiction.

G. Dust Control: To prevent unnecessary spread of dust during performance of the work of this Section, thoroughly moisten surfaces and debris as required to prevent dust being a nuisance to the public, neighbors, and concurrent performance of other work on the site. Water for use in dust control shall be obtained from Contractor's own source.

H. Explosives and Blasting: Not allowed in performance of demolition work.

I. Environmental Requirements: Maintain soil erosion and sediment control measures as required in Section 31 25 00.

1.7 SEQUENCING AND SCHEDULING

A. Unfinished Work:
   1. Sequence and schedule work with consideration for the stability of the areas of the structure not intended for removal or are intended for removal at a later time.
   2. Provide and secure bracing, shoring, or lateral supports to shore unstable areas created as a result of any cutting, removal, or demolition work.

1.8 PROTECTION OF EXISTING VEGETATION

A. Refer to Section 01 56 39: Temporary Tree and Plant Protection.

1.9 EXISTING SERVICES

A. General: Indicated locations are approximate; determine exact locations before commencing work.

B. Arrange and pay for disconnecting, removing, capping, and plugging utility services. Notify affected utility companies in advance and obtain approval before starting this Work.

C. Place markers to indicate location of disconnected services. Identify service lines and capping locations on Project Record Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Temporary Materials: Materials needed or required for temporary protection in the form of barricades, fences, enclosures, etc., may be used construction materials of sound condition and reasonably clean. However, the condition of these materials shall meet or exceed the requirements of governing agencies or approving bodies as may be involved with the work.

B. Equipment: Equipment, machinery and apparatus (motorized or otherwise) used to perform the demolition and removal work may be used as chosen at the Contractor's discretion, but which will perform the work within the limits of the Contract requirements.
1. Select Earth Backfill: On site excavated material free of plant life, lumber, metal, refuse and rocks or similar hard objects larger than three inches in any dimension.

2. Aggregate Backfill: Conforming to PENNDOT Type 2A Section 703.2.

3. Sand: Natural or manufactured sand conforming to ASTM C 33.

4. Concrete: Class B (3000 psi) as specified in Section 03 30 53 – Miscellanous Cast-in-Place Concrete.

5. Lean Concrete: 2000 psi compressive strength at 28 days with minimum cement content per cubic yard in accordance with current ready-mix plant standard practice.
   a. Reduced Aggregate: Aggregate with particle size not less than 1/8-inch or more than 1/2-inch in any dimension and a maximum of five percent of the particles passing a No. 8 sieve.

6. Pipe Plug Materials: Where existing storm or sanitary piping is being abandoned in place construct pipe plugs in the open ends of such pipe using the following materials:
   a. Manhole Brick: Commercially manufactured brick made from clay or shale and burned, conforming to ASTM C 32, Grade MS.
   b. Waterproofed Mortar: Conforming to requirements of ASTM C 270 for Type M, 2500 psi. Parts by volume include: One part cement, 1/4 part lime, and sand at not less than 2½ nor more than 3 times the sum of the volumes of cement and lime used and of the following materials:
      1) Waterproofing Agent: Medusa Waterproofing Powder by Medusa Portland Cement Co.; Hydratite by Grace Construction Materials; or Hydrolox by Chem-Master Corp. Add the Medusa product in the ratio of two pounds per bag of cement; add the other products per manufacturer’s recommendations.
      2) Portland Cement: Conforming to ASTM C 150, Type I.
      3) Hydrated Lime: Conforming to ASTM C 207, Type S.
      4) Sand: Conforming to ASTM C 144.
      5) Water: Clean and free from deleterious amounts of acids, alkalis, and organic materials.

7. All required plugs, caps, flanges and other items required for disconnected utilities shall be approved by the appropriate utility companies.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS:

A. The means and methods of performing demolition (and removal) operations are the sole responsibility of the Contractor.


3.2 EXAMINATION

A. Field Inspection: Prior to performance of the actual work, carefully inspect the sites of the indicated and annotated demolition work and locate those objects, structures, and partitions designated to be demolished and removed.
   1. Verify with the Engineer the objects, structures, and partitions to be demolished and removed.
   2. Subsurface conditions
      a. Any available data concerning subsurface materials or conditions has been obtained by the retained Engineer for its own use in designing this project. Its accuracy or completeness is not guaranteed by the Owner or the Engineer and in no event is it to be considered as part of the contract plans or specifications.
Contractors must assume all risks in excavating for this project and shall not be entitled to rely on any subsurface information obtained from the retained Engineer. Bidders shall therefore make their own investigation of existing subsurface conditions and if they do not do so, the Owner will not be responsible in any way for the consequences. Said subsurface information is available at the office of Engineer. Bidders will be required to sign a standard form of receipt for this subsurface information; and such bidders accept such subsurface information in accord with the provisions of this section.

b. The contract drawings show information obtained by the Engineer regarding the location of pipes, conduits, storm sewers and other structures which exist along the lines of work below the surface of the ground. This information is shown for the convenience of the Contractor who must verify in advance the information given to his own satisfaction. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, notify the Engineer immediately. Cooperate with the Owner and utility companies in keeping their respective services and facilities in operation. Repair damaged utilities to the satisfaction of the utility owner. Do not interrupt existing utilities servicing facilities occupied or those being used except when services have been provided. No extras will be paid for additional utilities encountered or utilities shown in the wrong location.

B. Utilities: Locate existing exposed and buried active utilities and determine the requirement for their protection, or their disposition with respect to the demolition work.
1. Electrical: Disconnect or de-energize on-site electrical wiring close to or entering structures to be demolished. Coordinate with the Pennsylvania State University for necessary relocation of utilities.
2. Water: Disconnect or cap on-site water lines close to or entering structures to be demolished. Protect existing fire control hydrants and repair damaged hydrants. Coordinate with the Pennsylvania State University for necessary relocation of utilities.
3. Sanitary and Storm Sewers: Disconnect or cap sanitary sewers and storm drains close to or exiting structures to be demolished.
4. Coordinate all utility relocation with the Owner and utility company. Cap all utilities in a location approved by the Owner. Use approved cap materials.

C. Exterior Dust Control: To minimize unnecessary spread of dust during performance of exterior demolition work, thoroughly moisten surfaces and debris as required to prevent dust being a nuisance to the public, neighbors, and concurrent performance of other work on the site. Water for use in dust control shall be obtained from Contractor’s own source and shall be potable water.

D. Protection of Public:
1. If public safety could be endangered during the progress of the demolition work, provide adequate protective measures to protect public pedestrian and vehicular traffic on streets and walkways.
2. Signs, signals, and barricades used shall conform to requirements of Federal, State and local laws, rules, regulations, precautions, orders, and decrees.

E. Explosives and Blasting: Not allowed in performance of demolition work.

F. Asbestos: Cease work immediately and notify the Engineer if suspected asbestos is encountered that has not been previously identified.

G. Remediation: Conduct required remediation prior to commencing with work. If contaminated materials are encountered that have not been previously identified, cease work immediately, and notify Engineer.
H. Clearing: Clear vegetation only as necessary to complete work. Additional clearing not required to complete the work shall be as approved by the Owner.

3.3 PERFORMANCE

A. Arrange and pay for disconnecting, removing, capping, and plugging utility services. Notify affected utility companies in advance and obtain approval before starting this Work.

B. Place markers to indicate location of disconnected services. Identify service lines and capping locations on Project Record Documents.

C. General Requirements: The means and methods of performing demolition and removal operations are the sole responsibility of the Contractor. However, equipment used, and methods of demolition and removal will be subject to approval of The Owner and Engineer.
   1. When removing concrete slabs, saw cut such slabs at the limits of removal to assure a smooth, uniform joint with new concrete installation.
   2. When removing masonry, remove to the next full size unit so proper toothing in of new work may be done.
   3. Perform removal of masonry and concrete debris, keeping such debris dampened during removal.

D. Excavation and Backfilling: Perform work in accordance with the requirements of Sections 03 20 00, 31 22 00, and 31 23 33.13.
   1. Should the Contractor, in demolishing or removing existing facilities, such as existing pipelines, excavate below the subgrade for new facilities, he will be required to backfill the area excavated below the subgrade with Aggregate Backfill, at no increase in Contract Price.
   2. Backfill substructure cavities using Select Earth Backfill. Restore surfaces in the area of demolished structures to match the surrounding area.

E. Salvage: The Owner has the right to claim as salvage any of the materials and equipment removed under the work of this Section.
   1. Existing removed materials and equipment not claimed as salvage by the Owner shall become the property of the Contractor and be disposed of in a lawful manner off site.

F. Substructure Penetrations: As a general practice in the demolition work, and to prevent the future accumulation of water in the remaining portions of below grade structures after backfilling operations, break through the bottoms of such structures to the extent that water drainage readily occurs.

G. Abandoned Equipment and Machinery: Existing equipment and machinery in or on the structures, not claimed as salvage by the Owner, shall also become the property of the Contractor and shall be removed and disposed of in a lawful manner off site.

H. Capping Existing Facilities:
   1. Cap cut ends of water mains to be abandoned.
   2. Close existing corporation stops on water services to be abandoned except those on abandoned mains.

I. Removal and Filling Existing Valve Boxes:
   1. Remove top section of valve boxes indicated to be abandoned.
   2. Fill with aggregate backfill in layers not to exceed six inches in depth after compaction.
      a. Perform compaction by hand.
      b. Puddling or jetting compacting methods are not permitted.
J. Plugging Existing Pipelines: Provide watertight seals by constructing pipe plugs in the open ends of pipelines being abandoned in place. Use Manhole Brick and Waterproofed Mortar to construct the pipe plugs.

K. Plugging Existing Facilities: Provide watertight seals using Class B concrete. For large openings use Manhole Brick and Waterproofed Mortar.
   1. Plug openings in manholes that are to be abandoned or filled.
   2. Plug the ends of pipe sewers that are to be abandoned or filled.

L. Filling Manholes to be Abandoned: Remove the cone or tapered section of the manhole and fill the manhole cavity with Select Earth Backfill placed in layers not to exceed 6-inches in depth after compaction.
   1. Perform compaction with vibratory type compactor. Puddling or jetting compaction methods are not allowed.
   2. Fill manholes to subgrade of the temporary or permanent replacement paving or to the elevation of the adjacent surfaces.
   3. Crown the top surfaces of the Select Earth Backfill in unpaved areas to such heights as required by the Construction Manager.

M. Filling Sewers to be Abandoned: Fill abandoned sewers with Lean Concrete.

N. Structure Foundations: Remove all structure foundations entirely and backfill with Select Earth Backfill.

3.4 REPAIR/RESTORATION

A. General Requirements: At Contractor’s expense, repair or replace damaged structures, appurtenances, and vegetation not specified for removal.

B. Excavation and Fill: Fill pits and voids created by the work in accordance with Section 312000.

3.5 FIELD QUALITY CONTROL

A. Engineers Observation: Completely remove demolition debris from the site. Obtain approval from the Engineer prior to commencing with next phase of work.

3.6 CLEANING

A. Debris: Remove or store debris daily to prevent accumulation. Disposal of debris shall be conducted in a lawful manner.

B. Final Cleaning: Clean and restore work areas to the pre-work condition or better.

3.7 PROTECTION

A. Removal: Protect structures, site areas, and vegetation not designated for removal from damage during work.

B. Demolition: Protect existing utilities not scheduled for demolition.

3.8 SITE CLEARING

A. General: Remove trees, shrubs, grass, and other vegetation, improvements, or obstructions, as required, to permit installation of new construction. Remove similar items elsewhere on site or
premises as specifically indicated. Removal includes digging out and off-site disposal of stumps and roots.

B. Where existing trees are indicated to remain, leave existing topsoil in place within drip lines to prevent damage to root system.

C. Clearing and Grubbing: Clear site of trees, shrubs, and other vegetation, except for those indicated to be left standing.
   1. Completely remove stumps, roots, and other debris protruding through ground surface.
   2. Use only hand methods for grubbing inside drip line of trees indicated to remain.
   3. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.
   4. Place fill material in horizontal layers not exceeding 6 inches loose depth, and thoroughly compact each layer to a density of 100 percent of the maximum dry density under building, walkway, and pavement footprints and do not compact in planting areas.

D. Demolition and Removal of Improvements: Remove existing above-grade and below-grade improvements as indicated and as necessary to facilitate new construction.
   1. Saw cut edges of existing bituminous and concrete paving to be removed. Saw cuts are to be straight and clean.
   2. Demolish and remove all indicated existing site structures, such as footings, curbs, and foundation walls, completely.
   3. Demolish and remove all indicated existing walks completely to subgrade.
   4. Demolish and remove all indicated bituminous concrete paving and curbs completely to subgrade.

E. Abandonment or removal of certain underground pipe or conduits is indicated on demolition and site preparation plan. Remove abandoned underground piping or conduits interfering with construction as indicated on the plans.

END OF SECTION 02 41 00
SECTION 02 41 16 - STRUCTURE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Demolition and removal of buildings and site improvements.
2. Removing below-grade construction.
3. Disconnecting, capping or sealing, and abandoning in-place of removing site utilities.
4. Salvage of existing face brick for reuse in construction.

B. Related Sections:

1. Division 01 Section "Summary" for use of the premises and phasing requirements.
2. Division 01 Section "Construction Progress Documentation" for preconstruction photographs taken before building demolition.
3. Division 01 Section "Construction Waste Management and Disposal."
4. Division 02 Section "Selective Structure Demolition" for partial demolition of buildings, structures, and site improvements.
5. Division 23 Sections for demolishing or relocating site mechanical items.
6. Division 31 Section "Site Clearing" for site clearing and removal of above- and below-grade site improvements not part of building demolition.
7. Division 33 Section "Utility Relocation" for shutting off, disconnecting, removing, and sealing or capping utilities.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.
1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified refrigerant recovery technician.

B. Proposed Protection Measures: Submit informational report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.
   1. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain including means of egress from those buildings.

C. Schedule of Building Demolition Activities: Indicate the following:
   1. Detailed sequence of demolition work, with starting and ending dates for each activity.
   2. Temporary interruption of utility services.
   3. Shutoff and capping or re-routing of utility services.

D. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.

E. Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Division 01 Section "Photographic Documentation." Submit before the Work begins.

F. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

G. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.6 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.


D. Predemolition Conference: Conduct conference at Project site.
   1. Inspect and discuss condition of construction to be demolished.
   2. Review structural load limitations of existing structures.
   3. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
   4. Review and finalize protection requirements.
   5. Review procedures for noise control and dust control.
   6. Review procedures for protection of adjacent buildings.
1.7 OWNER’S REQUIREMENTS

A. All requirements listed below will be strictly enforced and supercede more general requirements included in referenced sections of this specification.

B. Demolition Contractor Prequalification - All structural / facility demolition bidders must be prequalified by PSU. See requirements on OPP website at: http://www.opp.psu.edu/planning-construction/contractor-prequalification-information.

C. PA DEP and US EPA Demolition Notifications - Demolition contractor, not general contractor, is responsible for completion and submittal. Draft forms are to be submitted to PSU EHS for review and approval prior to mailing to appropriate regulatory agencies. After approval from EHS, the demolition contractor shall submit to appropriate agencies and provide signed copies to EHS the same day, with proof-of-mailing. Demolition shall not begin until 10-working days after the approved notification is post-marked.

D. Site Fence within Primary Construction Enclosure - Shall be 8’ high cyclone wire or equivalent with hammered-in posts. Free standing fences are not permitted unless temporary for short duration operations. EHS approval for temporary free standing fence must be granted in advance.

E. Wetting and Dust Control - Demolition contractor is responsible for wetting debris from time of first contact until placing into appropriate waste or hauling containers or trucks. Debris shall not be allowed to dry before removal from site. Visible airborne dust is not permitted.

F. Wetting and Dust Control - Demolition contractor is responsible for providing water tank / pump trucks if on-site water flow or pressure is not sufficient for operations.

G. Asbestos - Every effort has been made to identify and remove all asbestos from the facility prior to demolition. If suspect asbestos is discovered cease operations and notify OPP and EHS immediately.

H. Contaminated Soil - If unusual stains or odors are detected in soils, cease demolition or excavation operations and notify OPP and EHS immediately.

I. Lead Paint and Clean Fill - All painted CMU, brick or concrete must be disposed as demolition debris at a PA DEP licensed landfill. These materials contain lead-based paint and cannot be reused on PSU or any other non-PSU sites.

J. Salvage of Painted Materials - Salvage of painted materials such as doors, windows, frames, moldings, etc. must be coordinated with EHS. End users of these materials must be provided with a Lead Paint Notification / Disclaimer before removing from PSU property.

1.8 PROJECT CONDITIONS

A. Buildings to be demolished will be vacated and their use discontinued before start of the Work.

B. Buildings immediately adjacent to demolition area will be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.

1. Provide not less than 72 hours’ notice of activities that will affect operations of adjacent occupied buildings.

2. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.

   a. Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.
C. Owner assumes no responsibility for buildings and structures to be demolished.
   1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   1. Hazardous materials will be removed by Owner before start of the Work.
   2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. On-site storage or sale of removed items or materials is not permitted.

1.9 COORDINATION
   A. Arrange demolition schedule so as not to interfere with Owner's on-site operations or operations of adjacent occupied buildings.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS
   A. Satisfactory Soils: Comply with requirements in Division 31 Section "Earth Moving."

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Verify that utilities have been disconnected and capped before starting demolition operations.
   B. Review Project Record Documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
   C. Inventory and record the condition of items to be removed and salvaged. Provide photographs of conditions that might be misconstrued as damage caused by salvage operations. Comply with Division 01 Section "Photographic Documentation."
   D. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during building demolition operations.

3.2 PREPARATION
   A. Refrigerant: Remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction before starting demolition.
   B. Existing Utilities: See Divisions 22 and 26 Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.
C. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of demolition.

3.3 PROTECTION

A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.

B. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.

1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and authorities having jurisdiction.
   a. Provide at least 72 hours' notice to occupants of affected buildings if shutdown of service is required during changeover.

C. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated. Comply with requirements in Division 01 Section "Temporary Facilities And Controls."

1. Protect adjacent buildings and facilities from damage due to demolition activities.
2. Protect existing site improvements, appurtenances, and landscaping to remain.
3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
4. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
5. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
6. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
7. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.

D. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

3.4 DEMOLITION, GENERAL

A. General: Demolish indicated buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
2. Maintain fire watch during and for at least 8 hours after flame cutting operations.
3. Maintain adequate ventilation when using cutting torches.
4. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
B. Engineering Surveys: During demolition, perform surveys to detect hazards that may result from building demolition activities.

C. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

D. Explosives: Use of explosives is not permitted.

3.5 DEMOLITION BY MECHANICAL MEANS

A. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.

B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.

2. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

   a. Carefully remove existing face brick to be reused or replaced as indicated on Drawings.

   b. Carefully remove existing limestone trim to be reused or replaced as indicated on the Drawings.

C. Below-Grade Construction: Demolish foundation walls and other below-grade construction.

1. Remove below-grade construction, including basements, foundation walls, and footings, completely.

2. Take care to preserve and protect adjacent utilities that are not part of this project and are not scheduled for removal.

D. Existing Utilities: Demolish existing utilities and below-grade utility structures that are within 5 feet outside footprint indicated for new construction. Abandon utilities outside this area.

1. Fill abandoned utility structures with approved material according to backfill requirements in Division 31 Section "Earth Moving."

2. Piping: Disconnect piping at unions, flanges, valves, or fittings.

3. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.
3.6 SITE RESTORATION

A. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.

B. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

3.7 REPAIRS

A. Promptly repair damage to adjacent buildings caused by demolition operations.

3.8 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and legally dispose of them in an EPA-approved landfill acceptable to authorities having jurisdiction. See Division 01 Section "Construction Waste Management and Disposal" for recycling and disposal of demolition waste.

   1. Do not allow demolished materials to accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Do not burn demolished materials.

3.9 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.

   1. Clean roadways of debris caused by debris transport.

END OF SECTION 02 41 16
SECTION 02 41 19 - SELECTIVE STRUCTURE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Demolition and removal of selected portions of building or structure.
   2. Salvage of existing face bricks for reuse in reconstruction.

B. Related Requirements:
   1. Division 01 Section "Summary" for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.
   2. Division 01 Section "Construction Waste Management and Disposal."
   3. Division 01 Section "Temporary Tree and Plant Protection" for temporary protection of existing trees and plants that are affected by selective demolition.
   4. Division 01 Section "Execution" for cutting and patching procedures.
   5. Division 02 Section "Structure Demolition" for demolition and removal of buildings and site improvements.
   6. Division 31 Section "Site Clearing" for site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.
B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For refrigerant recovery technician and demolition engineer.

B. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.

C. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

D. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.

E. Predemolition Photographs or Video: Submit before Work begins.

F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

G. Warranties: Documentation indicated that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.
B. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.8 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.9 OWNER’S REQUIREMENTS

A. All requirements listed below will be strictly enforced and supercede more general requirements included in referenced sections of this specification.

B. Demolition Contractor Prequalification - All structural / facility demolition bidders must be prequalified by PSU. See requirements on OPP website at: http://www.opp.psu.edu/planning-construction/contractor-prequalification-information.

C. PA DEP and US EPA Demolition Notifications - Demolition contractor, not general contractor, is responsible for completion and submittal. Draft forms are to be submitted to PSU EHS for review and approval prior to mailing to appropriate regulatory agencies. After approval from EHS, the demolition contractor shall submit to appropriate agencies and provide signed copies to EHS the same day, with proof-of-mailing. Demolition shall not begin until 10-working days after the approved notification is post-marked.

D. Site Fence within Primary Construction Enclosure - Shall be 8' high cyclone wire or equivalent with hammered-in posts. Free standing fences are not permitted unless temporary for short duration operations. EHS approval for temporary free standing fence must be granted in advance.

E. Wetting and Dust Control - Demolition contractor is responsible for wetting debris from time of first contact until placing into appropriate waste or hauling containers or trucks. Debris shall not be allowed to dry before removal from site. Visible airborne dust is not permitted.

F. Wetting and Dust Control - Demolition contractor is responsible for providing water tank / pump trucks if on-site water flow or pressure is not sufficient for operations.

G. Asbestos - Every effort has been made to identify and remove all asbestos from the facility prior to demolition. If suspect asbestos is discovered cease operations and notify OPP and EHS immediately.

H. Contaminated Soil - If unusual stains or odors are detected in soils, cease demolition or excavation operations and notify OPP and EHS immediately.

I. Lead Paint and Clean Fill - All painted CMU, brick or concrete must be disposed as demolition debris at a PA DEP licensed landfill. These materials contain lead-based paint and cannot be reused on PSU or any other non-PSU sites.

J. Salvage of Painted Materials - Salvage of painted materials such as doors, windows, frames, moldings, etc. must be coordinated with EHS. End users of these materials must be provided with a Lead Paint Notification / Disclaimer before removing from PSU property.

1.10 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
1. The area slated for selective demolition is presently occupied space. The Owner will have to temporarily relocate departments so that work in this area can take place. Therefore, work must be carefully scheduled and coordinated with Owner.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   
   1. Hazardous materials will be removed by Owner before start of the Work.
   2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   
   1. Maintain fire-protection facilities in service during selective demolition operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.

C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.
E. Engage a professional engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

F. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs.

1. Comply with requirements specified in Division 01 Section "Photographic Documentation."
2. Inventory and record the condition of items to be removed and salvaged. Provide photographs of conditions that might be misconstrued as damage caused by salvage operations.
3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

1. Comply with requirements for existing services/systems interruptions specified in Division 01 Section "Summary."

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off indicated utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.

   a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
   f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

C. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.
3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Comply with requirements for access and protection specified in Division 01 Section "Temporary Facilities and Controls."

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Division 01 Section "Temporary Facilities and Controls."

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly. Comply with requirements in Division 01 Section "Construction Waste Management and Disposal."

B. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.

B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

1. Carefully remove existing face brick to be reused or replaced as indicated on the Drawings.
2. Carefully remove existing limestone trim to be reused or replaced as indicated on the Drawings.

C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

D. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Division 01 Section "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.7 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19
SECTION 02 57 00 - SINKHOLE REMEDIATION [C]

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for excavating sinkholes and the subsequent treatment of such sinkholes.

B. Related Sections:
   1. Submittal Procedures: Applicable Division 1 specification section.

C. Measurement Procedures: The sinkhole treatment work performed will be measured as described in the General Conditions to determine the actual quantity of work included under this Section.

D. Payment Procedures: Actual sinkhole treatment work will be paid for as described in the General Conditions for the actual amount of work performed.
   1. Sinkhole remediation, if required, will be compensated based on the approved Contractor’s time and material proposal for this work. No additional payments will be made for difficulties encountered during excavation or handling of materials. [C]

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
   2. ASTM D 698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft·lbf/ft3 (600 kN·m/m3)).
   3. ASTM D 2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   5. ASTM D 5034, Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).

B. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Transportation Materials and Methods of Testing and Sampling:
      a. AASHTO M 6, Fine Aggregate for Portland Cement Concrete.
      b. AASHTO M 295, Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.

1.3 DEFINITIONS

A. Sinkhole: An area displaying evidence of existing or impending soil transport into openings, voids, or other avenues within bedrock and/or overburden, as determined by the Engineer.

B. Sinkhole Treatment: The location, exposure, cleaning, and plugging of sinkhole related openings, voids, or other avenues of soil transport performed as directed by the Engineer.
1.4 SUBMITTALS

A. Prior to the start of the work of this Section, submit the following information in accordance with the requirements of Section 01 33 00:

1. Product Data:
   a. Geotextiles.

2. Samples: Submit a one-foot square sample and a data sheet giving the results of the required testing for each of the following:
   a. Geotextiles.

3. Quality Assurance/Control Submittals:
   a. Mix designs:
      1) Concrete.
      2) Grout.
   b. Test Reports:
      1) Aggregate test reports.
      2) Concrete unconfined compressive strength test results.
      3) Grout unconfined compressive strength test results.

B. After the start of the work of this Section, submit the following information in accordance with the requirements of the applicable Division 1 specification section for Submittals.

1. Test Reports:
   a. Submit laboratory and field compaction test reports based on the methods specified under Reference Standards and as approved by the Engineer.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Perform all work in compliance with the rules and regulations of any governmental agencies having jurisdiction.

1.6 PROJECT CONDITIONS

A. Classification of Excavated Materials: No consideration will be given to the nature of materials encountered during sinkhole treatment operations.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete:

1. Provide a mixture of aggregate, Portland Cement, and water exhibiting a 28-day strength of at least 2000 psi.

2. Submit mix proportions of the concrete to the Engineer for approval.

B. Cement:

1. Provide cement conforming to the requirements of ASTM C 150, Type I or II.

C. Grout:

1. Provide a mixture of Portland cement, fine aggregate, flyash, and water exhibiting a 28-day strength of no more than 250 psi.

2. Submit mix proportions of the grout to the Engineer for approval.

D. Fine Aggregate:
1. Provide aggregate conforming to AASHTO M 6, or as approved by the Engineer.

E. Flyash:
1. Provide flyash meeting the requirements of AASHTO M 295, Type C or F, with a maximum Loss on Ignition of 5 percent.

F. Aggregate Backfill:
1. Provide one or more aggregates of the following types as directed by the Engineer:
   a. AASHTO #1.
   b. PENNDOT 2A.
   c. Rip Rap.


2.2 SOURCE QUALITY CONTROL

A. All materials specified in this Section require advance examination and testing according to the methods and standards referenced, or as required by the Engineer.
1. Furnish two copies of test reports to the Engineer certifying test results.
   a. These test reports may serve as the basis for acceptance or rejection of proposed materials.
2. The Engineer reserves the right to accept materials based on certification from suppliers that the material originates from an approved or accredited source and that the material complies with specified requirements.

PART 3 - EXECUTION

3.1 PREPARATION

A. Initiating Work: Begin sinkhole treatment at the direction of the Engineer, who will designate the areas to be treated.

B. Exposing the Sinkhole: Excavate soft, loose, or unstable material from the sinkhole area to the limits determined by the Engineer.

C. Cleaning Exposed Rock Surfaces:
1. Clean rock surfaces designated by the Engineer of soil or other deposits to produce a surface suitable for developing a positive concrete bond.
   a. Clean out crevasses and soil seams to a depth at least as great as the width of the feature at the top of rock.

D. Dewatering:
1. When required by the Engineer, provide and operate pumping equipment of suitable type and size to evacuate all water entering the sinkhole from washing operations or other sources.
2. Collection sumps may be required to facilitate dewatering operations, as determined by the Engineer.
E. Temporary Grading: As directed by the Engineer, perform temporary grading adjacent to the sinkhole area(s) to prevent the inflow of surface waters into the sinkhole(s).

3.2 SINKHOLE TREATMENT

A. Geotextile Placement:
   1. Place geotextile on prepared rock, concrete, or soil surfaces as directed by the Engineer.
   2. Maintain a minimum overlap of 2 feet between adjacent Geotextile panels.

B. Aggregate Backfill Placement:
   1. Place aggregate backfill to the limits indicated by the Engineer.
   2. Compact all aggregate backfill using approved methods to not less than 95 percent of the maximum dry density determined in accordance with ASTM D 698.
      a. If aggregate is too coarse to satisfactorily use this method, compact it to non-movement using methods approved by the Engineer.

C. Concrete and Grout Placement:
   1. Place concrete and grout to the limits indicated by the Engineer.
   2. If directed by the Engineer, vibrate concrete and grout thoroughly to penetrate narrow or restricted apertures and completely fill the indicated areas without forming voids or other discontinuities.

D. Low Permeability Backfill Placement:
   1. Place low permeability backfill material to the limits indicated by the Engineer.
   2. Compact backfill material using approved methods to not less than 95 percent of the maximum dry density determined in accordance with ASTM D 698.

E. Surface Grading:
   1. Unless otherwise directed by the Engineer, crown the final ground surface above repair area to provide positive drainage away from the repair, and to accommodate potential future settlement without compromising drainage.
   2. Provide a crown height as directed by the Engineer.

3.3 FIELD QUALITY CONTROL

A. Test the backfill compaction in the field using nuclear density gauge testing in accordance with the methods of ASTM D 2922 or other methods approved by the Engineer, and submit test reports to verify that the compaction meets the specified requirements.

END OF SECTION 02 57 00
SECTION 03 11 00 - CONCRETE FORMING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section covers the concrete formwork for construction of all concrete structures set forth on the Drawings and in these Specifications.

1.2 REFERENCES

A. American Concrete Institute (ACI):
   1. ACI 347, Guide to Formwork for Concrete.

B. U.S. Department of Commerce Product Standards:
   1. PS-1-95, Construction and Industrial Plywood.

C. Western Wood Products Association: Western Lumber Grading Rules 98.


1.3 SUBMITTALS

A. Form Coating: Submit manufacturer's descriptive product data and current specification covering named product.

B. Form Ties: Submit manufacturer's descriptive product data, current specification covering named product.

1.4 QUALITY CONTROL

A. Formwork Design: Provide formwork designed to ensure the tolerances indicated and to include factors pertinent to safety of personnel during construction.
   1. Design formwork in accordance with American Concrete Institute's Guide to Formwork for Concrete, ACI 347, and in accordance with the following:
      a. Design forms and falsework to include assumed values of live load, dead load, weight of moving equipment operated on formwork, temporary construction material, foundation pressures, stresses, lateral stability, and such other factors pertinent to safety of structure during construction.
      b. Design formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent construction.

B. Allowable Tolerances: Set and maintain concrete forms within tolerance limits stated in American Concrete Institute's Guide to Formwork for Concrete, ACI 347.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection:
1. Protect formwork materials before, during, and after erection to ensure acceptable finished concrete work. Also protect in-place materials and work of other trades in connection with concrete work.
2. In event of damage to erected forms, make necessary repairs or replacements prior to concrete pours. Perform such corrective work at no increase in Contract Price.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Lumber:
   1. Form framing, sheathing, struts, braces, and shoring in conformance with WWPA Grading Rules or SPIB Grading Rules.
   2. Rough Structural and Dimension Lumber: Provide lumber of allowable species, surfaced four sides as applicable, and grade stamped with the appropriate WWPA or SPIB stamp indicating product compliance with PS-20-94.
   3. Use lumber free of material defects that would deform the finished concrete product.

B. Plywood:
   1. Form Sheathing and Panels: Not less than 5/8 inch thick Exterior Type B-B Plywood Class I and II conforming to U.S. Product Standard PS-1-95.
   2. Use Class II only on surfaces not exposed to view.

C. Steel:
   1. Metal Forms of a pre-engineered standard design, conforming to the concrete sections indicated on the Drawings, may be used in lieu of wood forms.

D. Form Ties:
   1. Provide factory-fabricated, adjustable-length, removable, or snap-off metal form ties conforming to ACI 347.
      a. Do not fabricate wire ties, flat bands, or form ties on the Site.
   2. Removable Ties:
      a. For ties that are designed to be completely removed, taper the ties over their full length that passes through the concrete.
         1) For building foundation walls where ground is located on one side only, install tapered ties so the large end of the taper is on the ground side of the concrete wall.
      b. Do not use removable ties that leave holes larger than one inch.
   3. Snap-off Metal Ties:
      a. Provide snap-off metal ties with ends that break at least 1½ inches from the face of the wall.
   4. Do not use wood spacers.
   5. Submit Product Data and current specifications for the form tie materials.

E. Form Coatings:
   1. Provide commercial formulation form-coating compounds that do not bond with, stain, or affect concrete surfaces.
      a. Provide form-coating compounds that do not impair subsequent treatment of concrete surfaces requiring bond or adhesion, or impede the wetting of surfaces to be cured with water or curing compounds.
PART 3 - EXECUTION

3.1 INSPECTION

A. Prior to placement of concrete, inspect forms for cleanliness and accuracy of alignment.

3.2 PREPARATION

A. Apply form coatings in accordance with manufacturer’s specifications.
B. Do not allow excess form coating material to accumulate in the forms.
C. Do not allow form coatings to come in contact with construction joints and reinforcing steel.

3.3 ERECTION

A. General: Construct forms in accordance with ACI 347 to required dimensions, plumb, straight, mortar tight, and paste tight where appearance is important.
   1. Securely brace and shore forms to prevent displacement, bowing and pillowing, and to safely support imposed concrete load.
   2. Provide offsets, keyways, recesses, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and such other features as required. Use selected materials to obtain above requirements.
   3. Fabricate forms for easy removal without hammering or prying against concrete surfaces.
   4. Form intersecting planes to provide true, clean-cut corners with edge grain of plywood not exposed to concrete.
   5. Build into forms, or otherwise secure in forms, items such as inserts, anchors, miscellaneous metal items, and such other embedded items as indicated on Drawings.
   6. Wet forms sufficiently to prevent joints in wood forms from opening prior to concrete pour.
   7. Do not use stay-in-place metal forms.

B. Earth Forms: Earth forms are not permitted.

3.4 CONSTRUCTION

A. Form Removal
   1. Remove forms in accordance with ACI 347 without damage to concrete and in a manner to ensure complete safety and serviceability of the structure.
      a. Do not cut form ties back from the face of the concrete.
      b. Concrete surface shall not contain residual form coating that will interfere with other materials or coatings to be applied.
      c. Concrete containing slag ground granulated blast furnace slag tends to develop strength slower than a concrete containing 100 percent Portland Cement.
   2. Do not remove supporting forms or shoring until the members have acquired sufficient strength to safely support their weight and the anticipated construction loads without distortion or excessive deflection. Consent to remove forms does not relieve the Contractor of the responsibility for the safety of the work.
   3. When the atmospheric temperature at the site has been continuously above 50 degrees F from the time of the pour, the forms shall be removed at the earliest practical time within the limits set forth in this paragraph, and wet curing shall continue without delay.
      a. Forms for walls and other vertical faces may be carefully removed 24 hours after the last portion of concrete in the section involved has been placed, provided the concrete has sufficiently hardened to preclude damage resulting from form
removal, and provided these members are not subjected to loads for a period of 14 days.

b. Maintain horizontal forms in place for a minimum of 14 days or until the concrete, as determined by job-cured cylinders, has attained a compressive strength of 3,000 p.s.i. unless noted otherwise.

c. When a water-reducing retarder is used in the concrete mix, the normal time periods for removing forms may need to be increased.

4. When the atmospheric temperature at the site drops below 50 degrees F, leave all forms in place for at least 5 days regardless of the temperature within the protective covering or enclosure. Upon removal of forms, notify the Construction Manager in order that a review of the newly stripped surfaces may be made before patching.

3.5 RE-USE OF FORMS

A. Forms for re-use shall meet new form requirements with respect to effect on poured concrete appearance and structural stability.

B. Do not delay or change the concrete pour schedule as a result of reusing forms compared to the schedule obtainable if all forms were new (in the case of wood forms) or if the total required forms were available (in the case of metal forms).

END OF SECTION 03 11 00
SECTION 03 20 00 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The work specified in this Section consists of furnishing and installing reinforcement for concrete structures.

1.2 RELATED SECTIONS

A. Section 03 30 53: Miscellaneous Cast-in-Place Concrete.

1.3 REFERENCES

A. American Concrete Institute (ACI):
   1. ACI 315; Details and Detailing of Concrete Reinforcement.
   2. ACI 318-02; Building Code Requirements for Structural Concrete.

B. American Society for Testing and Materials (ASTM):
   1. ASTM A 82; Specification for Steel Wire, Plain, for Concrete Reinforcement.
   2. ASTM A 185; Specification for Steel Welded Wire Reinforcement, Plain, for Concrete Reinforcement.
   3. ASTM A 615; Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   4. ASTM A 36; Specification for Carbon Structural Steel.

C. Concrete Reinforcing Steel Institute: Manual of Standard Practice.

1.4 SUBMITTALS

A. Shop Drawings and Product Data:
   1. Prepare shop drawings of concrete reinforcement in accordance with American Concrete Institute's ACI 315.
   2. Provide drawings showing all fabrication dimensions and locations for placing reinforcement and bar supports; indicate bending diagrams, splicing and lap of rods, shapes, dimensions and details of bar reinforcing and accessories.
   3. Product Data: Submit manufacturer’s descriptive product data and current specification for each product specified herein, include installation instructions.

B. Test Reports:
   1. Submit copies of reports showing the results of tests, conducted in accordance with the American Society for Testing and Materials Specifications.
   2. Test Requirements may be waived based upon certified copies of mill test reports.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage of Materials:
   1. Store reinforcing materials in a manner to prevent excessive rusting and fouling with dirt, grease and other bond-breaking coatings.
   2. Identify bundles of reinforcing steel with tags wired to steel.
1.6 PROJECT CONDITIONS

A. Protection: Protect in-place reinforcement from excessive construction traffic and other work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Reinforcing Steel:
1. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.
2. Wire: ASTM A 82.

B. Rebar Splicing Coupler: A two-piece splicing system manufactured from ASTM A 615 Grade 60 deformed rebar. A dowel bar splicer with integral nailing flange shall be threaded for a threaded dowel-in rebar such that the completed splice exceeds the tensile requirements of ACI 318.
1. Internal Coupler Protector: Provide coupler manufacturer’s plastic internal coupler protector where couplers are provided for anticipated future additions.
2. Bar End Protectors: Plastic solid sleeve for placement over bar ends to protect threading from damage, contamination, and rust.
3. Use Rebar Splicing Coupler only where shown on Drawings or where approved by the Engineer.
4. Acceptable Manufacturers:
   a. Dayton Superior Corp.
   b. Or equal.

C. Deformed Bar Anchors: ASTM A 108 cold worked, deformed wire per ASTM A 496 with minimum yield strength of 50 ksi and minimum ultimate tensile strength of 61 ksi. Bar anchor shall be low carbon steel with the following properties C -0.23 max, Mn – 0.90 max, P – 0.040 max and S – 0.050 max.
1. Anchors shall be similar to Nelson, flux-filled deformed bar anchor, Type D2L, by Nelson Stud Welding or equal.

2.2 FABRICATION

A. General: Fabricate reinforcement to the dimensions indicated on the Drawings and within the tolerances given in ACI 315. Perform bending of steel reinforcement by the cold bending method.
1. Do not use bars with kinks or bends not indicated on Drawings.
2. Perform bar shape fabrication in a manner that will not injure the material or lessen the member strength.
3. Use a designed bending machine, either hand- or power-operated.
4. Do not field bend bars partially embedded in concrete unless approved by the Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Placing:
1. Place metal reinforcement accurately and securely brace against displacement within permitted tolerances and in accordance with ACI 318 through the use of reinforcing accessories.
2. Continue reinforcement across or through construction joints.
3. When obstructions interfere with the placement of reinforcement, pass such obstructions by placing reinforcing around it. Do not bend the reinforcing to clear the obstructions.
4. Install welded wire fabric as indicated, lapping joints eight inches and wiring securely. Extend welded wire fabric to within two inches of sides and ends of slabs.
5. Do not lay metal reinforcement on formwork.
6. Place slab reinforcement supported from the ground on concrete blocks of the correct height and having a compressive strength equal to or greater than the specified compressive strength of concrete being placed. Use concrete blocks not larger than 3 inches by 3 inches with a height equal to required bottom steel cover.
7. Place additional reinforcement around openings in slabs and walls as detailed on the Drawings.
8. Reinforcement supported from formwork for slabs, use bar chairs made of plastic or metal.
9. Deformed bar anchors shall be field welded to slab edge steel bent plate as shown on the drawings.

B. Splicing:
1. Splice metal reinforcement as indicated on the Drawings and in accordance with ACI 318.
2. Welding of crossing bars (tack welding) is not permitted.
3. Secure metal reinforcement at intersections with not less than No. 16-gauge annealed wire or appropriate size clips. When bar spacing is less than 12 inches, tie alternate intersections.
4. Make mechanical butt splice in accordance with rebar splicing coupler manufacturer’s installation instructions.

C. Slab Joint Dowel Bar Installation:
1. Install one-half the length of coated bar dowel into slab to be poured.

D. Cleaning:
1. Clean or otherwise protect metal reinforcement so that at the time concrete is placed, reinforcement is free from rust, scale or other coatings that will destroy or reduce bond.

E. Concrete Reinforcement Protection:
1. Provide protection for reinforcement during concrete pours in accordance with ACI 318, unless indicated otherwise on the Drawings.

3.2 INSPECTION

A. Notify Construction Manager 48 hours before placing concrete so he can inspect placement of metal reinforcement.

END OF SECTION 03 20 00
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Work of this section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

B. Select Environmentally preferable materials that conserve natural resources, encourage sustainable stewardship of resources, minimize the generation of waste and pollution during construction, and contribute to a healthy permanent building environment.

C. The essence of this Project is to complete the Work using sustainable design and construction standards, as defined by the Owner. These standards include, but are not limited to: incorporating low-environmental-impact items into the Work; using recycled content; obtaining products from suppliers within 500 miles of Project site; employing construction practices that minimize negative environmental effects on the site and surrounding area. Any and all proposals by any and all Contractors will be evaluated according to these standards. The Owner reserves the right to reject any product or method that, in Owner’s sole opinion, is in conflict with these standards.

D. Contractors are responsible for submitting LEED certifications as indicated in subsequent sections of the specification.

1.02 ENVIRONMENTAL ISSUES (This section is for information only. For requirements related to meeting environmental goals, see instructions in the body of this specification following this section).

A. Problems:
   1. Production of Portland cement is energy intensive and emissions contribute significant amounts of carbon dioxide and particulates to the atmosphere.
   2. Mining of coarse and fine aggregate can cause local pollution and damage to natural habitats.
   3. Discarded formwork generates waste.
   4. Some curing compounds, release agents and sealers emit VOC’s especially during the curing process, compromising indoor air quality and contributing to ground level ozone, also known as “smog”.
   5. Residual water generated by wash-out of transit mix truck drums can cause localized pollution.

B. Solutions:
   1. Use byproducts from other processes (fly ash, slag, silica fume, rice hull ash) as supplementary cementitious materials added to the concrete as a "blended cement" or as a separately batched ingredient proportioned for the performance requirements of the Project. Use of byproducts diverts this material from landfills while reducing Portland cement requirements.
2. Use gray water in production of ready mixed concrete. See ASTM C94 for guidelines and requirements.

3. Demolition concrete is a great source of aggregate. Using recycled aggregate in place of virgin aggregate reduces mining and diverts waste material from landfills. Uses range from sub-base material to coarse aggregate in structural concrete.

4. Recycle, reuse or use alternative formwork systems

5. Specify low VOC or water or vegetable – based curing compounds, form release agents and sealers.

1.03 WORK INCLUDED

A. Work of this section includes all labor, materials, equipment and services necessary to complete the concrete work as shown on the drawings and specified herein, including, but not limited to the following:

1. Foundation systems including walls, footings, piers, pits, etc.
2. Slabs on grade.
3. Structural slabs on metal deck.
4. Stair pan fills.
5. Furnishing and installing all required anchors and inserts.
6. Placing in the forms all inserts, anchors, anchor bolts, bearing plates, etc. furnished by other trades for casting into the concrete and cleaning of same after stripping of forms.
7. Protection of all inserts, anchors, hangers, sleeves and supports furnished and set by others for the attachment of other work to the concrete, or required to permit the passage of other work through the concrete.
8. Supply, fabricate and place all required reinforcing bars, mesh and other reinforcement for concrete where shown, called for, and/or required complete with proper supporting devices.
9. Erection and removal of all formwork required to properly complete the work.
10. Finishing of all concrete work as hereinafter specified.
11. Curing and protection of all concrete work.
12. Site walls and structures, excluding curbs, walks and paving as shown on the drawings.
13. Floor sealers and dustproofing of all areas exposed and/or covered with carpet.
14. Patching, grouting, and pointing up as required.
15. Vapor barrier system below slabs on grade.
17. Grouting of all beam bearing plates and column base plates.
18. Embedded plates in all foundation walls.
19. Equipment pads as required.
20. All other work and materials as may be reasonably inferred and needed to make the work of this section complete.

1.04 RELATED WORK
A. Masonry work.
B. Structural steel.
C. Metal deck.
D. Miscellaneous metal work.
E. Earthwork.
F. Carpentry.
G. Dewatering.
H. Waterproofing.
I. Site curbs, walks and paving

1.05 SUBMITTALS

A. Product Data: Submit data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others as requested by Architect.

B. Shop Drawings; Reinforcement: Submit original shop drawings for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315 "ACI Detailing Manual" showing bar schedules, stirrup spacing, diagrams of bent bars, arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures. The shop drawings shall be prepared only by competent detailers, checked by the contractor prior to submission.
   1. The shop drawings shall show all construction joint locations and the added reinforcement required at same.
   2. Obtain and coordinate information for sleeves and openings in concrete, which are required for the work of other trades. Make coordinated drawings showing size and location of openings, sleeves, and additional reinforcing, and incorporate this information on the reinforcing drawings.
   3. Only those splices indicated on the approved shop drawings will be permitted.
   4. Provide elevations of all foundation walls and other structural elements to a minimum 1/4" scale.

C. Slab Edge, Penetration and Embedment Drawings: Submit a fully coordinated plans at each level that dimension to scale all embedded items, all items that penetrate the slab and slab edges. Information shown shall include, but not be limited to, conduits, piping, inserts, anchors, bearing plates, slab depressions or block-outs, etc.

D. Samples: Submit samples of materials as requested by Architect, including names, sources and descriptions.

E. Laboratory Test Reports: Submit laboratory test reports for concrete materials, mix design test and microwave test.
F. Material Certificates: Provide materials certificates in lieu of materials laboratory test reports when permitted by Architect. Manufacturer and Contractor shall sign material certificates, certifying that each material item complies with, or exceeds, specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

G. Recycled Aggregate: Provide laboratory reports indicating that aggregate conforms to relevant ASTM standards and recommendations. Provide cut sheets clearly indicating the source, total weight and volume of the recycled aggregate. If aggregate provided is a mix of virgin and recycled aggregates obtain a written affidavit from the manufacturer stating the recycled content percentage.

H. Formwork Shop Drawings: Submit shop drawings signed and sealed by a professional engineer licensed in the Commonwealth of Virginia for fabrication and erection of specific finished concrete surfaces. Show form construction including jointing, special form joint or reveals, location and pattern of form tie placement, and other items which affect exposed concrete visually.

1. Architect's review is for general architectural applications and features only. Design of formwork for structural stability and efficiency is Contractor's responsibility.

I. LEED Submittals:
1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
   a. Include statement indicating costs for each product having recycled content.
2. Credit MR 5.1: List of proposed regionally manufactured materials and regionally extracted, harvested, or recovered materials.
   a. Identify each regionally manufactured material, its source, and cost.
   b. Identify each regionally extracted, harvested, or recovered material, its source, and cost.
   c. Include statement confirming the following, and identifying the nearest town for each indicated location.
      1) Distance between location of manufacture and Project site.
      2) Distance between location of extraction, harvesting, or recovery, and Project site.

1.06 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:
1. Governing Building Codes having jurisdiction over the project.
2. ACI 117-90 "Standard Specifications for Tolerances for Concrete Construction and Materials".
3. ACI Manual of Concrete Practice (Latest Edition)
4. CRSI-WCRSI, "Placing Reinforcing Bars".
5. AWS D1.4, "Structural Welding Code - Reinforcing Steel".
6. The ACI Field Reference Manual, SP-15 shall be kept at the job site, and the practices set forth therein shall be strictly adhered to.
8. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice".
9. ASTM C 618 “Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete”
10. ASTM C 989 “Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars”

B. Should materials and installed work require testing and retesting at anytime during progress of work, tests, including retesting of rejected materials for installed work, shall be performed at Contractor's expense.

1.07 PROJECT CONDITIONS:

A. The contractor, before commencing work, shall examine all adjoining work on which this work is in any way dependent for proper installation and workmanship according to the intent of this specification, and shall report to the Architect/Engineer, any condition, which prevents this contractor from properly performing their work.

B. Protection of Footings Against Freezing: Cover completed work at footing level with sufficient temporary or permanent cover as required to protect footings and adjacent subgrade against possibility of freezing; maintain cover for time period as necessary.

C. Protect adjacent finish materials against spatter during concrete placement.

D. Provide all barricades and safeguards at all pits, holes, shaft and stairway openings, etc., to prevent injury to workmen and others within and about the premises. Also provide all safeguards as required by the Building Code, OSHA, or any other departments having jurisdiction. Take full responsibility for all safety precautions and methods.

PART 2 - PRODUCTS

2.01 FORM MATERIALS
A. Forms for Exposed Finish Concrete: Unless otherwise indicated, construct of plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material with sufficient strength and thickness to withstand pressure of newly placed concrete without bow or deflection.

1. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class I, Exterior Grade or better, mill oiled and edge-sealed, with each piece bearing legible inspection trademark.

B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.

C. Form Coatings: Provide VOC compliant commercial formulation form-coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces. Use bio. Use biodegradable form release agent listed below or equivalent made from soy or rapeseed oil.

1. Soy Form Away by Cure & Seal by Natural Soy Products,
4. For additional products see GreenSpec Product Directory, BuildingGreen Inc at www.buildinggreen.com

D. Form Ties: Form ties and spreaders: prefabricated assemblies by Richmond; Superior, Dayton or approved equal. Wire ties shall not be used for formwork support. Ties for foundation work shall be of snap design with removal cones and water seal washer.

E. Load Bearing Foam Formwork: Dow High Load 60 Styrofoam or equal.

2.02 REINFORCING MATERIALS

A. Deformed Reinforcing Bars: ASTM A615, Grade 60. Minimum recycled content 85%.

B. Steel Wire: ASTM A82, plain, cold-drawn steel.


E. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI specifications.
   1. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class I) or stainless steel protected (CRSI, Class 2), at a spacing not to exceed 4'-0" on center in either direction.

F. Mechanical Couplers: Mechanical couplers for reinforcing shall develop 125 percent of the specified yield strength of the reinforcing bars being spliced.

G. Use recycled plastic rebar supports (give preference to local supplier if available)
   1. New Century Northwest – Eugene, OR 541-342-5400
   2. Eclipse Plastic – Snohomish, WA tel: 1-800-278-4276

2.03 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I or I/II: Use one brand of cement throughout project, unless otherwise acceptable to Architect.

B. Pozzolans and Slags: Must be completely accounted for in the design mix. Replace Portland cement by weight with not less than 25% for Fly Ash OR not less than 40% for Ground Granulated Blast Furnace Slag. Mix design must meet minimum design requirements set in the contract documents, additional admixtures may be required to meet early strength requirements AND alternative cementitious material goals. Note: If a "blended cement" is used which already contains a certain percentage of Pozzolans or Slags this content may offset or entirely satisfy the minimum percentage required.
   1. Coal Fly Ash: ASTM C618, Type C or Type F.
   3. Blended hydraulic cement, as defined by ASTM C595 or ASTM C 1157.
   4. Alternative pozzolans: Silica Fume (ASTM C 1240) and Rice Hull (or “husk”) Ash. ASTM C618, are acceptable with the approval of the Engineer.

C. Normal Weight Aggregates: ASTM C 33, and as herein specified. Provide aggregates from a single source for exposed concrete.
   1. Normal weight Fine Aggregate: washed, inert, natural or manufactured or combination thereof, sand conforming ASTM C33 gradation.
   2. Normal weight Coarse Aggregate: well graded crushed stone or washed gravel conforming to ASTM C33, sizes #57 for foundations, slabs and structure.

D. Lightweight Aggregates: ASTM C 330. Well-graded crushed expanded shale produced by rotary kiln method. 3/4" maximum aggregate size. Lightweight aggregate shall be saturated surface dry prior to addition of mix water. W/C ratio shall account for aggregate moisture content.
E. Water: Free from oils, acids, alkali, organic matter and other deleterious material to conform to ASTM C94.

F. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

Products: Subject to compliance with requirements, provide one of the following:

"Air-Mix": Euclid Chemical Co.
"MB-VR": Master Builders.
"Sika Aer": Sika Corp.
"Darex AEA": W.R. Grace.

G. Water-Reducing Admixture: ASTM C 494, Type A, and containing not more than 0.05 percent chloride ions.

Products: Subject to compliance with requirements, provide one of the following:

"Eucon WR-75 or WR-89": Euclid Chemical Co.
"Pozzolith Normal": Master Builders.
"Plastocrete 160": Sika Chemical Corp.
"WRDA Hycol": W.R. Grace.

H. High-Range Water-Reducing Admixture (Superplasticizer): ASTM C 494, Type F or Type G and containing not more than 0.05 percent chloride ions.

Products: Subject to compliance with requirements, provide one of the following:

"Eucon 37": Euclid Chemical Co.
"Rheobuild 1000": Master Builders.
"Sikament 300": Sika Chemical Corp.
"Daracem-100": W. R. Grace.

I. Water Reducing, Non-Corrosive Accelerating Admixture: The admixture shall conform to ASTM C 494, Type C or E, and not contain more chloride ions than are present in municipal drinking water. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year's duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures.

Products: Subject to compliance with requirements, provide the following:

"Accelguard 80": Euclid Chemical Co.
"Daraset": W. R. Grace
"Pozzutech 20": Master Builders
J. Water-Reducing, Retarding Admixture: ASTM C 494, Type D, and contain not more than 0.05 percent chloride ions.

Products: Subject to compliance with requirements, provide one of the following:

"Eucon Retarder 75": Euclid Chemical Co.
"Pozzolith Retarder": Master Builders.
"Plastiment": Sika Chemical Co.
"Daratard": W.R. Grace.

L. Prohibited Admixtures: Calcium chloride, thyocyanates or admixtures containing more than 0.05 percent chloride ions are not permitted.

M. Certification: Written conformance to the above-mentioned requirements and the chloride ion content of admixtures will be required from the admixture manufacturer prior to mix design review by the Engineer.

N. Contractor will be required to provide information demonstrating successful use in prior placement involving all admixtures.

O. Penetrating Sealers: At concrete slabs or topping slabs directly exposed to weather (except at locations where floors are coated with a finish or a traffic bearing membrane is to be installed) and as indicated, provide silane or siloxane penetrating sealer.

Products: Subject to compliance with requirements, provide the following or approved equal:

"Enviroseal 40": Hydrozo Water Repellent Systems
"Price Aqua Silane-40": Price Research, LTD.

Q. Fly Ash: ASTM C 618, Type C or Type F.

R. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.

2.04 RELATED MATERIALS

A. Waterstops: Grace Adcore ES self-expanding strip waterstops.

B. Granular Base: (Underslab drainage course): ¾” to 1” crushed stone, gravel, or recycled concrete aggregate as approved by Engineer to provide, when compacted, a smooth and even surface below slabs on grade and where indicated. The material shall be:

1. Be provided only from PennDOT approved sources.
2. Be quarried from the following formations in the Central Pennsylvania region:
   Limestone
   Nealmont Formation (Rodman and Centre Hall members)
Linden Hall Formation (Valentine, Valley View, and Stover members)
Snyder Formation
Hatter Formation
Dolostone
Belleville Formation (Tea Creek and Coffee Run members)
Nittany Formation
Mixed Limestone and Dolostone
Axemann Formation

3. The selected aggregate material shall meet PENNDOT specifications and these additional restrictions:
   a) Contain less than 0.5% pyrite (i.e. 0.3% S)
   b) Contain less than 1% deleterious materials
   c) Limit the sulfur content to 0.1% if it is in the form of frambooidal pyrite in a carbonaceous shale or as whisker pyrite veins
   d) Contain less than 15% thin, elongate, or platy pieces.

4. Provide advance examination and testing according to methods referenced, or as required by the Professional, for aggregate materials.
   a) Conduct aggregate quality tests in accordance with requirements of PENNDOT Section 703.
   b) Conduct petrographic examination of aggregate samples representative of proposed material according to procedure defined in ASTM C 295. Examination shall be performed by an experienced petrographer.
   c) Conduct chemical analysis of aggregate samples representative of proposed materials according to procedure defined in ASTM C 1580.
   d) Professional reserves the right to accept aggregate materials based on certification from supplier that aggregate originates from a source approved by PENNDOT and that the aggregate complies with specified PENNDOT requirements and the additional requirements included herein.

5. Contractor providing stone or aggregate shall submit Independent Testing Agency test results indicating compliance with the above conditions prior to the start of work every three months thereafter. In addition, Independent Testing Agency shall perform testing of aggregate samples any time the source of stone or aggregate is changed. [C]

C. Non-Shrink, Non-Metallic Grout: The non-shrink grout shall be a factory pre-mixed grout and shall conform to ASTM C1107, "Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)."

Products: Subject to compliance with requirements, provide one of the following:

"Euco-NS": Euclid Chemical Co.
"Five Star Grout": U.S. Grout Corp.
"Masterflow 713": Master Builders.

D. High Flow Grout: Where high fluidity and/or increased placing time is required, use high flow grout. The factory pre-mixed grout shall conform to ASTM C1107,
"Standard Specification for Packages Dry, Hydraulic-Cement Grout (Non-shrink)." In addition, the grout manufacturer shall furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95% bearing under a 18" x 36" base plate.

Products: Subject to compliance with requirements, provide one of the following:

"Euco Hi-Flow Grout": Euclid Chemical Co.
"Masterflow 928": Master Builders

E. Non-slip Aggregate Finish: Provide fused aluminum oxide grits, or crushed emery, as abrasive aggregate for non-slip finish with emery aggregate containing not less than 40% aluminum oxide and not less than 25% ferric oxide. Use material that is factory-graded, packaged, rustproof and non-glazing, and is unaffected by freezing, moisture, and cleaning materials.

F. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

G. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
   1. Waterproof paper.
   2. Polyethylene film.
   3. Polyethylene-coated burlap.

H. Curing Compounds: Clear Curing and Sealing Compound (VOC Compliant): The compound shall have 30% solids content minimum, and will not yellow under ultra violet light after 500 hours of test in accordance with ASTM D4887 and will have a maximum moisture loss of 0.039 grams per sq. cm. when applied at a coverage rate of 250 sq. ft. per gallon.

Products: Subject to compliance with requirements, provide one of the following:

"Super Aqua Cure": Euclid Chemical Co.
"Super Diamond Clear VOX": Euclid Chemical Co.
"MasterKure 200W": Master Builders

I. Curing/Hardening Compound: The product shall be a sodium silicate based compound which reacts with concrete constituents to harden the surface. The film is gone in seven (7) days.

Products: Subject to compliance with requirements, provide one of the following:

"Eucosil": Euclid Chemical Company
"Sonosil": Sonneborn

J. Crack Sealer: Elastomeric liquid crack sealer resistant to water, gasoline, oil and salts.
Products: Subject to compliance with requirements, provide one of the following:

"Plasti-seal": Euclid Chemical Co.
"Sikadur 35, Hi Mod LV LPL": Sika

K. Underlayment Compound: Free flowing, self-leveling, pumpable cementitious base compound.

Products: Subject to compliance with requirements, provide the following:
"Flo-Top": Euclid Chemical Co.
"Ardex": Ardex Co.
"Underlayment 110": Master Builders

L. Bonding Admixture: The compound shall be a latex, non-rewettable type.

Products: Subject to compliance with requirements, provide one of the following:
"Flex-Con": Euclid Chemical Co.
"Daraweld C": W.R. Grace
"SBR Latex": Euclid Chemical Co.

M. High Strength Polymer Repair Mortar: For form and pouring or large horizontal repairs, provide the flowable on-part, high strength repair mortar.

Products: subject to compliance with requirements, provide the following:
"Eucocrete": The Euclid Chemical Company
"Euco Speed MP" (Cold Weather): The Euclid Chemical Company

N. Evaporation Retardant – Products: Subject to compliance with requirements, provide one of the following:
"Eucobar": Euclid Chemical Co.
"Confilm": Master Builders

O. Vapor Barrier: Provide vapor barrier cover over prepared base material where indicated below slabs on grade. Use only materials, which are resistant to decay when tested in accordance with ASTM E 1745, Class A.

Products: Subject to compliance with requirements, provide one of the following:
“Premoulded Membrane Vapor Seal with Plasmatic Core” W.R. Meadows Seal Tight

P. Liquid Densifier: The liquid densifier compound shall be a siliconate-based sealer, which penetrates concrete surfaces, increases abrasion resistance and provides a "low-sheen" surface.

Products: Subject to compliance with requirements, provide one of the following:
"Euco Diamond Hard": Euclid Chemical Co.
2.05 PROPORTIONING AND DESIGN OF MIXES

A. Preparation of Design Mixes: All mix designs shall be proportioned in accordance with ACI 318, ACI 301, and prepared by the Ready-Mix supplier who will be supplying concrete to the project. Submit separate mix designs on each class of concrete for review.
   1. If previously used mixes are submitted, all materials shall be from the same sources and with the same brand names as the previously utilized mix.
   2. If trial batches are used, the mix design shall be prepared by an independent testing laboratory and shall achieve an average compressive strength 1200 psi higher than the specified strength.
   3. The proposed mix designs shall be accompanied by complete standard deviation analysis or trial mixture test data.

B. Submit each proposed mix on the mix design submittal form (included at the end of this specification) to the Architect and Structural Engineer for review at least 5 days prior to the pre-concrete conference. Do not begin concrete production until Architect has reviewed and approved mixes.

C. Design mixes to provide normal weight concrete with the properties shown on the drawings and following additional properties:
   1. Cementitious Material replacement for concrete mixes at all concrete shall be 25% minimum and 50% maximum using one of the following: Ground Granulated Blast Furnace Slag (GGBFS) or Fly Ash.
   2. Provide Crystalline waterproofing admixture to walls specified as crystalline waterproofed. Add to mix per manufacturer's recommendation. Maintain specified concrete strengths.
   3. Maximum cementitious materials content shall not exceed 600 lb./cy.

E. Lightweight Concrete: Proportion mix as herein specified. Provide mix to produce strength as noted on drawings, with a split-cylinder strength factor (Fct) of not less than 5.5 and a dry weight of not less than 105 pcf or more than 115 pcf after 28 days. Limit shrinkage to 0.03 percent at 28 days.

F. Adjustment to Concrete Mixes: Mix design adjustments may be requested in writing by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to Owner and as accepted by Architect. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect before using in work.

G. Admixtures:
1. Use water-reducing admixture or high range water-reducing admixture (super plasticizer) in all concrete as required for placement and workability.

2. Use non-corrosive, non-chloride accelerating admixture in concrete slabs placed at ambient temperatures below 50°F (10°C).

3. Use high-range water-reducing admixture in pumped concrete, concrete required to be watertight, and concrete with water/cement ratios below 0.50.

4. Use air-entraining admixture in exterior concrete exposed to freeze/thaw conditions, unless otherwise indicated. Add air-entraining admixture at manufacturer’s prescribed rate to result in concrete at point of placement having total air content of 6 percent with a tolerance of plus-or-minus 1-1/2 percent. Otherwise, provide air-entrainment as follows:
   a. Other Concrete: (not exposed to freezing, thawing, or hydraulic pressure): 2 percent to 4 percent air.
   b. Concrete subjected to vehicular traffic: 3 percent maximum.

5. Use admixtures for water-reducing and set-control in strict compliance with manufacturer’s directions.

H. Water-Cementitious Materials Ratio: Provide concrete for following conditions with maximum water-cementitious materials (W/C) ratios of 0.45, or as indicated in the drawings and in related specifications, except as follows:
   1. Loading dock; W/C 0.40.

I. Slump Limits: Proportion and design mixes to result in concrete slump as follows:
   1. 2” to 4” slump prior to addition of water-reducing admixtures. 8” maximum slump after addition of water-reducing admixtures.

J. Chloride Ion Level: Chloride ion content of aggregate shall be tested by the laboratory making the trial mixes. The total chloride ion content of the mix including all constituents shall not exceed the limitations set forth in Table 4.4.1 of ACI 318 for concrete subjected to deicers or exposed to chloride in service (0.15 chloride ions by weight of cement).

K. Aggregate Gradation: Well graded from coarsest to finest in accordance with ASTM C33 for normal weight course and fine aggregate and ASTM C330 for lightweight course aggregate.

2.06 CONCRETE MIXING

A. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.
B. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced at the plant and on site.

C. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required. When air temperature is between 85°F (30°C) and 90°F (32°C), reduce maximum mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90°F (32°C), reduce maximum mixing and delivery time to 60 minutes unless concrete is cooled and temperature is maintained at an acceptable level.

D. A maximum of 10% of the total volume of water of a batch may be withheld from the mix at the plant and added on site. This water limit shall not be exceeded and shall not be used to re-temper the concrete. No water shall be added after placing of concrete from a batch has begun.

E. No water shall be added after mixing to concrete containing HRWR (Superplasticizer). If loss of slump occurs, the concrete treated with HRWR may be retempered as long as a "flash set" has not occurred. Retempering procedures must be discussed and approved by the Engineer and the manufacturer at the Pre-Concrete Conference. Water shall not be added to concrete at the site.

2.07 PRE-CONCRETE CONFERENCE:

A. At least 14 days prior to the start of the concrete construction schedule, the contractor shall conduct a meeting to review the proposed mix designs and to discuss the required methods and procedures to achieve the required concrete construction. The contractor shall send a pre-concrete conference agenda to all attendees 7 days prior to the scheduled date of the conference.

B. The contractor shall require responsible representatives of every party who is concerned with the concrete work to attend the conference, including but not limited to the following: Contractor's superintendent, Quality Control Testing and Inspection Agency, Concrete subcontractor, Ready-mix concrete producer.

C. Minutes of the meeting shall be recorded, typed and printed by the contractor and distributed by him to all parties concerned within 5 days of the meeting. One copy of the minutes shall also be transmitted to the following for information purposes: Owner's representative, Quality Control Testing and Inspection Agency, Structural engineer.

D. The minutes shall include a statement by the admixture manufacturer(s) indicating that the proposed mix design and placing can produce the concrete quality required by these specifications.
E. The Structural Engineer will be present at the conference. The Contractor shall notify the Structural Engineer at least 7 days prior to the scheduled date of the conference.

PART 3 - EXECUTION

3.01 GENERAL

A. Coordinate the installation of joint materials, embedded items and vapor retarders with placement of forms and reinforcing steel.

3.02 INSPECTION

A. Examine all work prepared by others to receive work of this section and report any defects affecting installation to the contractor for correction. The contractor’s commencement of work will be interpreted as their complete acceptance of preparatory work by others.

3.03 CONCRETE STRENGTH

A. Concrete shall develop the minimum compressive strengths shown on drawings at 28 days when sampled and tested in accordance with ASTM C31 and C39.

B. Fly Ash Concrete & Slag Concrete: Concrete mixes containing high volumes of fly ash or Slag have slower set times and may take up to 56 days to reach full strength. The structural engineer, agency responsible for concrete mix design, the architect and the concrete subcontractor must coordinate to ensure that the form stripping schedule is consistent with the ability of the structure to support itself and all imposed construction loads.

3.04 FORMS

A. Design, erect, support, brace and maintain formwork to support vertical and lateral, static, and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size, shapes, alignment, elevation and position. Maintain formwork construction tolerances complying with ACI 117. Provide Class A tolerances for concrete exposed to view. Provide Class C tolerances for other concrete surfaces.

B. Design formwork to be readily removable without impact, shocks or damage to cast-in-place concrete surfaces and adjacent materials.

C. Construct forms to size shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, keyways, recesses, moldings, rustications, reglets,
chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.

D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, recesses, and the like, to prevent swelling and for easy removal.

E. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.

F. Chamfer exposed corners and edges as indicated, using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

G. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.

H. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed. Retightening forms and bracing after concrete placement is required to eliminate mortar leaks and maintain proper alignment.

3.05 VAPOR BARRIER INSTALLATION

A. At slabs not detailed with mud slabs and below slab waterproofing: Following leveling and compaction of granular base for slabs on grade, place vapor retarder sheeting with longest dimension parallel with direction of pour. Adjust retarder placement details to conform with installation and performance requirements for finishes.

B. Lap joints 6" and seal with appropriate tape in accordance with manufacturer’s requirements.

C. Avoid cutting or puncturing vapor retarder during reinforcement placement and concreting operations.

3.06 PLACING REINFORCEMENT
A. Comply with Concrete Reinforcing Steel Institute’s recommended practice for placing reinforcing bars, for details and methods of reinforcement placement and supports, and as herein specified.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials, which reduce or destroy bond with concrete.

C. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing using metal chairs, runners, bolsters, spacers, and hangers, as required.

D. Place reinforcement to obtain coverage's for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh increment and lace splices with tie wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

3.07 JOINTS

A. Construction Joints: Locate and install construction joints as indicated, or if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to Architect.
   1. Provide keyways at least 1-1/2" deep in construction joints in walls, slabs and between walls and footings; accepted bulkheads designed for this purpose may be used for slabs. Keyways, where waterproofing is to be adhered to joint, shall be troweled smooth.
   2. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints, except as otherwise indicated.
   3. Construction joints in steel deck slabs shall be located within the middle third of a deck span when parallel to beams and at least 8 times the slab thickness from a girder or ½ the distance between girders for joints parallel to girders.

D. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Fabricate field joints in waterstops in accordance with manufacturer’s printed instructions, using manufacturer's specified welding irons.

E. Isolation Joints in Slabs-on-Ground: Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams and elsewhere as indicated.
   1. Joint filler and sealant materials are specified in Division-7 sections of these specifications.
F. Contraction (Control) Joints in Slabs-on-Ground: A dry cut early entry saw, including Soff-Cut or approved equal shall be used to a minimum depth of 1-1/2", or 1/4 slab thickness, immediately after final finishing when concrete is firm enough to support equipment. Saw shall not damage surface or dislodge aggregate.

1. Joint sealant material is specified in Division-7 sections of these specifications.

3.08 INSTALLATION OF EMBEDDED ITEMS

A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of items to be attached thereto.

B. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting type screeds.

C. Embedded Plates at Foundation Walls: Install plate at top of forms so that exterior face of steel plate is level and plumb. Use construction documents for locations, sizes and elevations.

3.09 PREPARATION OF FORM SURFACES

A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.

B. Coat contact surfaces of forms with a form-coating compound before reinforcement is placed.

C. Thin form-coating compounds only with thinning agent of type, and amount, and under conditions of form-coating compound manufacturer’s directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer’s instructions.

D. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.10 CONCRETE PLACEMENT

A. Ready-mix concrete shall comply with the requirements of ASTM C94 and ACI 304. All plant and transporting equipment shall comply with the concrete plant
standards and truck mixer and agitator standards of the National Ready Mix Concrete Association.

B. Cold and hot weather mixing procedures shall be submitted to the architect for approval.

C. Notify architect and testing organization at least 36 hours (1 1/2 regular working days) before each pour so that forms and reinforcing may be examined. Do not place concrete until inspection has been made by the owner provided independent testing agency.

D. Preplacement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other trades to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.
   1. Apply temporary protective covering to lower 2' of finished walls adjacent to poured floor slabs and similar conditions, and guard against spattering during placement.

E. General: Comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete", and as herein specified.

F. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

G. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 18" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints. Use internal vibrators penetrating both the top and preceding layers.

H. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI recommended practices.

I. Use and type of vibrators shall conform to ACI 309 "Recommended Practice for Consolidation of Concrete". Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.
J. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.

K. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

L. Bring slab surfaces to correct level with straightedge and strikeoff. Use highway straightedge, bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations. See also "MONOLITHIC SLAB FINISHES" below.

M. Maintain reinforcing and embedded items in proper position during concrete placement operations. All reinforcement and embedded items shall be tied or secured in position prior to concrete placement. "Wet-Setting" of reinforcement or embedded items is not permitted.

N. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.
1. When air temperature has fallen to or is expected to fall below 40°F (4°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C), and not more than 80°F (27°C) at point of placement.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Use only a non-corrosive, non-chloride accelerator. Calcium chloride, thiocyanates or admixtures containing more than 0.05% chloride ions are NOT permitted.
4. Cold weather may require lower proportions of pozzolans & slags be used in the cementitious mix.

O. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F (32°C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.
2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
3. Fog spray forms, reinforcing steel and subgrade just before concrete is placed.
4. Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing conditions.

P. Deflection: The concrete subcontractor shall provide additional concrete required to accommodate expected deflection of building structure, deck and/or formwork occurring during concrete placement.

3.11 FINISH OF FORMED SURFACES

A. Concrete mixes containing pozzolans or slags do not set at the same rate or with the same bleed water characteristic as plain Portland cement. Therefore attention must be directed to the proper procedures. Refer to ACI 232.2R-10 and ACI 301

B. Rough Form Finish: For formed concrete surface not exposed to view in the finish work or by other construction, unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.

C. Smooth Form Finish: For formed concrete surfaces exposed-to-view, or that are to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, damp-proofing, painting or other similar system. This is as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed. Follow all requirements in ACI 301, Chapter 10 for smooth form finish. Surface preparation for surfaces receiving waterproofing must be approved by the waterproofing manufacturer prior to construction.

3.12 FLOOR FLATNESS/LEVELNESS TOLERANCES

A. Ff defines the maximum floor curvature allowed over 24 in. Computed on the basis of successive 12 in. (300 mm) elevation differentials, Ff is commonly referred to as the "Flatness F-Number".

B. Fl defines the relative conformity of the floor surface to a horizontal plane as measured over a 10 ft. (3.05 m) distance commonly referred to as the "Levelness F-Number".

C. All floors shall be measured in accordance with ASTM E-1155 "Standard Test Method for Determining Floor Flatness and Levelness Using the "F Number" System (Inch-Pound Units).

D. All slabs shall achieve the specified overall tolerance. The minimum local tolerance (1/2 bay or as designated by the architect) shall be 2/3 of the specified tolerances.
E. Unless noted otherwise, Floor Flatness (Ff) and Floor Levelness (Fl) shall comply with the requirements set forth in ACI 302 “Guide For Concrete Floor and Slab Construction”, Figure 8.15.1.1 for no-slope slabs.

F. For sloping slabs tolerance shall be in accordance with ACI 117.

3.13 MONOLITHIC SLAB FINISHES

A. Float Finish: Apply float finish to slabs at crawl spaces or horizontal surfaces to be waterproofed or covered with concrete toppings or drainage courses, unless otherwise noted. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture. Surface shall achieve an Ff 20 - Fl 17 tolerance.

B. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system, unless otherwise noted.
   1. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance and with a surface leveled to an Ff25/ Fl 20 tolerance (Fl 17 for elevated slabs). Grind smooth surface defects, which would telegraph through applied floor covering system.

C. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, and slab surfaces which are to be covered with membrane or elastic waterproofing, or sand-bed terrazzo, and as otherwise indicated, apply single trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming. Surface preparation for surfaces receiving waterproofing must be approved by the waterproofing manufacturer prior to construction

D. Liquid Densifier: Apply a coat of the specified liquid densifier to all exposed interior concrete floors where indicated on the drawings. This surface must be continuously moist cured by a method satisfactory to the Architect. Apply and mechanically scrub compound into the floor in strict accordance with the manufacturer's printed instructions.

3.14 CONCRETE CURING AND PROTECTION
A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Submit for approval, the contractor's proposed curing and protection method.
1. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
2. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.
3. In order to avoid plastic or drying shrinkage cracks during warm, dry or windy weather, ACI 302 and ACI 308 shall be followed using wind breaks and sun shades when recommended. Evaporation retardant shall be as specified in Section 2.04.

B. Curing Methods: Perform curing of concrete by moist curing or moisture-retaining cover curing as preferred methods, or by using curing, sealing and hardening compound when that is not practical, or by combinations thereof, as herein specified.
1. Provide moisture curing by following methods.
   a. Keep concrete surface continuously wet by covering with water.
   b. Continuous water-fog spray.
   c. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.
2. Provide moisture-cover curing as follows: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Provide curing and sealing compound to exposed interior slabs not receiving a liquid densifier application, and to all troweled slabs receiving mastic applied adhesives or "shake-on" hardeners. Curing compounds shall be compatible with floor finishes toppings and/or adhesives to be applied. This compound shall also be used on exterior slabs, sidewalks and curbs not receiving a penetrating sealer.
4. Provide curing and hardening compound to walls receiving the specified waterproofing system. The compound must be applied immediately after form removal, unless the forms are left on for seven (7) days.

C. Curing Formed Surfaces: Cure formed concrete surfaces, including undersides of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
D. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of the specified curing compound or a continuous moist curing method approved by the architect.

E. Sealer and Dustproofer: Apply a second coat of the specified curing and sealing compound to exposed interior slabs not subjected to vehicular traffic, noted on the drawings. These slabs must have received an initial coat of the curing and sealing compound.

3.16 REMOVAL OF FORMS

A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50°F (10°C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as beam soffits, joints, slabs and other structural elements, may not be removed in less than 7 days or until concrete has attained 75% of the specified compressive strength. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members. The contractor shall notify the quality control testing agency 24 in advance in the event that field-cured specimens are required.

C. Form facing material may be removed 2 days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports and surfaces are treated for proper curing.

3.17 RE-USE OF FORMS

A. Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.

B. When forms are intended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to Architect.

3.18 MISCELLANEOUS CONCRETE ITEMS

A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other
trades is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

D. Grout base plates and foundations as indicated using specified non-shrink grout. Use non-metallic grout for exposed conditions, unless otherwise indicated. Where high fluidity and/or increased placing time is required using the specified high flow grout.

E. Steel Pan Stairs: Provide concrete fill for steel pan stair treads and landings and associated items. Cast-in safety inserts and accessories as shown on drawings. Screeds, tamp, and finish concrete surfaces as scheduled.

3.19 CONCRETE SURFACE REPAIRS

Prior to all repairs, an as-built condition sketch and method of repair must be submitted to the architect and engineer for review and approval.

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Architect.

B. Cut out honeycomb, rock pockets, voids over 1/4" in any dimension, and holes left by tie rods and bolts, down to solid concrete but, in no case to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with a bonding grout containing the specified bonding admixture. Place patching mortar after while bonding grout is still tacky.

C. For exposed-to-view surfaces, blends white portland cement and standard portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

D. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins and other projections on surface; and
stains and other discoloration's that cannot be removed by cleaning. Flush out form tie holes, fill with dry pack mortar, or pre-cast cement cone plugs secured in place with bonding agent.

E. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.

F. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for tureens of slope, in addition to smoothness, using a template having required slope.

G. Repair finished unformed surfaces that contain defects, which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01" wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions shall be repaired.

H. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days, except at hydrostatic slabs.

I. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. The specified underlayment compound or repair topping may be used when acceptable to Architect.

J. Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.

K. Repair isolated random cracks and single holes not over 1" in diameter by dry-pack method. Groove top of cracks and cutout holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry-pack after bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.
L. Structural Repair: All structural repairs shall be made with prior approval of the Engineer as to method and procedure, using the specified polymer repair mortar and/or specified epoxy adhesive. Where epoxy injection procedures must be used, an approved low viscosity epoxy made by the manufacturers previously specified shall be used. All garage slabs shall be repaired prior to the slab being treated with the specified penetrating anti-spalling sealer. In addition, all cracks shall be filled with the specified crack sealer or other method as approved by the Engineer.

M. Underlayment Application: Leveling of floors for subsequent finishes may be achieved by use of specified underlayment material. Underlayment application shall achieve the tolerances specified in "MONOLITHIC SLAB FINISHES" above.

N. Specified Polymer Horizontal Repair Mortar: All exposed floors shall be leveled, where required, with the specified self-leveling repair topping.

O. Repair Methods not specified above may be used, subject to acceptance of Architect.

3.20 FOUNDATION WALLS

A. Form and leave openings in walls as shown on drawings and approved shop drawings for work of other contractors. These openings shall be temporarily closed and when so directed, the contractor shall point up in solid and neat manner with waterproofed cement.

3.21 WORK IN CONNECTION WITH OTHER TRADES AND CONTRACTS

A. Sleeves, pockets, openings, etc., shall be set in the concrete walls and arches as required for the mechanical trades as shown on approved shop drawings; these shall be encased or built into the concrete work and shall be properly placed and secured in position in the forms before concrete is placed. Provide additional reinforcing around all penetrations in walls and slabs as shown on the contract drawings.

B. Provide all chases, pipe slots, etc., required for the mechanical trades (see mechanical drawings), constructed as shown on the approved shop drawings.

C. Leave temporary access panels where required to install mechanical equipment as required by trade affected. Panels shall be formed with construction joints as specified. Details for such panels shall be submitted to Architect for approval.

D. Coordinate all penetrations, cutting, and patching with waterproofing contractor.

E. Moisture Vapor Emission Rates (MVER): Concrete slabs to receive specialty floor finishes shall meet all moisture vapor emission rates and curing
requirements necessary for satisfactory installation of the floor systems indicated. Acceptable values for MVER and testing methods for determining acceptability of MVER shall be in accordance with the flooring manufacturer’s requirements.

3.22 CUTTING AND PATCHING

A. Contractor for concrete work shall be responsible for all cutting, removing and patching work where concrete surfaces are not installed within the limits shown on the drawings or specified herein. All such work shall meet with the approval of the Architect/Engineer.

B. The location and extent of cutting and patching in concrete work shall be submitted for review and approval by the Architect/Engineer.

3.23 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. The Owner will employ a third party testing laboratory to perform tests and to submit test reports.

B. Sampling and testing for quality control during placement of concrete may include the following, as directed by Architect.

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
2. Slump: ASTM C 143; one test at point of discharge when taking test cylinders or when concrete quality is suspect; additional tests when concrete consistency seems to have changed.
3. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete, measured at point of placement.
4. Concrete Temperature: Test hourly when air temperature is 40°F (4°C) and below, and when 80°F (27°C) and above; and each time a set of compression test specimens made.
5. Compression Test Specimen: ASTM C 31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
6. Compressive Strength Tests: ASTM C 39; one set for each day’s pour exceeding 5 cu. yds. (for each class of concrete) plus additional sets for each 100 cu. yds. over and above the first 5 cu. yds. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen tested at 56 days or to be withheld at the direction of the architect.
   a. When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
b. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

c. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.

6. Water Cement Ratio Test: Check water content of hardened concrete that is suspect in quality in accordance with ‘Standard Method of Test for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying, AASHTO DESIGNATION: TP 23, SHRP DESIGNATION: 2027’.

7. Unit Weight Test: In accordance with ASTM C138. Complete one test a day for 100 yards or more.

9. Test results will be reported in writing to Architect, Structural Engineer and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.

1. Non Compliance: All test reports indicating non-compliance shall be faxed immediately to all parties on the test report distribution list and the hard copies submitted on different colored paper.

2. Nondestructive Testing: Windsor probes, rebound hammer, sonoscope, or other non-destructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

10. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests and retesting when unacceptable concrete is verified.

END OF SECTION 03300
SECTION 03 30 53 - MISCELLANEOUS CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The work specified in this Section consists of designing mix, furnishing, placing, and curing Portland Cement concrete, reinforced and unreinforced, as indicated.

1.2 RELATED SECTIONS

A. Section 03 11 00: Concrete Forming.

B. Section 03 20 00: Concrete Reinforcing.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. AASHTO M 182 Burlap cloth made from Jute or Kenaf.

B. American Concrete Institute (ACI):
   2. ACI 211.1; Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
   3. ACI 301; Specifications for Structural Concrete.
   4. ACI 304R; Guide for Measuring, Mixing, Transporting and Placing Concrete.
   5. ACI 305R; Hot Weather Concreting.
   6. ACI 306R; Cold Weather Concrete.
   7. ACI 308; Guide to Curing Concrete.
   8. ACI 318; Building Code Requirements for Structural Concrete.

C. American Society for Testing and Materials (ASTM):
   1. ASTM C 31; Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   2. ASTM C 33; Specification for Concrete Aggregates.
   3. ASTM C 39; Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   4. ASTM C 42; Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   5. ASTM C 94; Specification for Ready-Mixed Concrete.
   6. ASTM C 138; Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
   7. ASTM C 143; Test Method for Slump of Hydraulic Cement Concrete.
   8. ASTM C 150; Specification for Portland Cement.
  10. ASTM C 171; Specification for Sheet Materials for Curing Concrete.
  11. ASTM C 172; Standard Practice for Sampling Freshly Mixed Concrete.
  12. ASTM C 173; Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
  13. ASTM C 192; Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
  14. ASTM C 231; Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
  15. ASTM C 260; Specification for Air-Entraining Admixtures for Concrete.
16. ASTM C 309; Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
17. ASTM C 494; Specification for Chemical Admixtures for Concrete.
19. ASTM C 882; Test Method for Bond Strength of Epoxy–Resin Systems used with Concrete by Slant Shear.
22. ASTM D 1751; Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
23. ASTM D 1752; Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
24. ASTM E 329; Specification for Agencies Engaged in the Testing and / or Inspection of Materials used in Construction.

D. U.S. Army Corps of Engineers (USACE) Specifications:

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive product data and current specifications for the concrete accessories specified herein. Include installation instructions.

B. Samples: Submit samples of materials being used when requested by the Engineer including names, sources, and descriptions.

C. Design Mix: Prior to production of concrete, submit for approval, on form attached at the end of this Section, all mix designs proposed for project. Include with the mix design a standard deviation analysis or trial mixture test data in accordance with ACI 301 Section 4.2.3. Use materials in such proposed design mix as specified herein. Make such adjustments in the proposed design mix as directed by the Engineer. Make such adjustments at no increase in contract price.
1. Water shall not be added to concrete mix at the project site unless it is withheld from the mix at the batch mixing plant. Indicate amounts of mix water to be withheld for later addition at project site.

D. Test Reports:
1. Submit concrete test reports specified in Part 3 in this Specification.

E. Certificates:
1. Furnish certificates originated by the batch mixing plant certifying ready mixed concrete, as manufactured and delivered, to be in conformance with ASTM C 94.

F. Delivery Tickets: A delivery ticket shall accompany each load of concrete from the batch plant.
1. Tickets must be signed by the Contractor's representative, noted as to time and place of pour, and kept in a record at the site. Make such records available for inspection upon request.
2. Information presented on the ticket to include the tabulation covered by ASTM C 94, Section 16, as well as any additional information the local codes may require.

G. Schedule: Submit schedule showing methods, construction joint locations, and sequence of pouring a minimum of 10 days prior to placing concrete.
1.5 QUALITY ASSURANCE TESTING


B. Source Quality Control:
   1. Laboratory Tests: Materials stated herein require advance examination or testing according to methods referenced, or as required by the Engineer.
   2. Compression Test Cylinders: For laboratory trial batches, make in accordance with American Concrete Institute ACI 301. Test to consist of four compression test cylinders for each class of concrete with two broken at seven days and two broken at 28 days; ASTM C 192 and ASTM C 39.

C. Pre-Job Meeting: Prior to placement of concrete, a meeting shall occur on site to establish and coordinate procedures that will enable Contractor to provide the best possible product under anticipated field conditions. The meeting should be attended by representatives of organizations and material suppliers involved with the design and construction of floor slab.

1.6 PROJECT CONDITIONS

A. ACI Compliance: Cast-in-place concrete work shall conform to ACI 301 except as modified by these Specifications or the Drawings.

B. Concrete Encasement of Pipes and Conduits: Encase pipes under structures and buildings indicated by the Drawings to be encased in concrete for the full length of the pipe run under the structure.

C. Concrete Encasement of Conduits: Encase conduit runs as indicated and detailed on the Drawings as work of Division 16 – Electrical Sections.

D. Equipment Bases: Construct reinforced concrete bases for equipment and piping under this contract at no increase in contract price.

1.7 SEQUENCING

A. Where other construction work is relative to concrete pours, or must be supported by or embedded in concrete, those performing such related work must be given five days notice to introduce or furnish embedded items before concrete is placed.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cement:
   2. Only one brand and manufacturer of approved cement shall be used for exposed concrete.

B. Normal weight Concrete Aggregates: Process aggregate meeting requirements of ASTM C 33 and subject to the following limitations.
   1. Coarse Aggregate Size: Maximum size of coarse aggregate shall not exceed the following requirements but in no case larger than 1½ inches.
      a. One-fifth narrowest dimension between sides of forms within which concrete is to be cast.
b. Three-fourths of the minimum clear spacing between reinforcing bars.
c. One-third the slab thickness for unreinforced slabs.
d. Reduced aggregate concrete containing aggregate with particle size not less than
   1/8 inch nor more than 1/2 inch in any dimension and a maximum of 5 percent of
   particles passing a No. 8 sieve (for use in metal pan stairs only).

C. Ground Granulated Blast-Furnace Slab (GGBFS): Conform to ASTM C 989, Grade 120.
   1. Use GGBFS at the rate of 25% (min) to 35% (max) of the total cementitious material.

D. Water: Clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or
   other substances that may be deleterious to concrete or reinforcement.

E. Concrete Admixtures:
   1. Prohibited Admixtures: Use only non-corrosive, non-chloride admixtures.
   2. Provide admixtures produced and serviced by established, reputable manufacturers and
      use in compliance with manufacturer's recommendations.
   4. Water-Reducing Admixture: Use a product conforming to requirements of ASTM C 494
      Type A. (Use this for all concrete except where an admixture listed below is used).
      a. Acceptable Manufacturers:
         1) Eucon WR-75; The Euclid Chemical Company.
         2) Pozzolith 220N; Master Builders.
         3) Plastocrete 161; Sika Corporation.
         4) Or approved equal.
   5. Water-Reducing and Retarding Admixture: Use a product conforming to requirements of
      ASTM C 494, Type D.
      a. Acceptable Manufacturers:
         1) Eucon Retarder-75; The Euclid Chemical Company.
         2) Pozzolith 100XR; Master Builders.
         3) Plastiment; Sika Corporation.
         4) Or approved equal.
   6. Water-Reducing, and Acceleration Admixture: Use a product conforming to requirements
      of ASTM C 494, Types C or E.
      a. Acceptable Manufacturers:
         1) Accelguard 80; The Euclid Chemical Company.
         2) Pozzutec 20; Master Builders.
         3) Plastocrete 161 FL; Sika Corporation.
         4) Or approved equal.
   7. High-Range, Water-Reducing Admixture: Use a Product Conforming to Requirements of
      ASTM C494, Type F.
      a. Acceptable Manufacturers:
         1) Eucon 1037; The Euclid Chemical Company.
         2) Pozzolith 400N; Master Builders.
         3) Sikament 2000; Sika Corporation.
         4) Or approved equal.
   8. Store admixtures in a manner to prevent contamination, evaporation, moisture
      penetration, or damage. Do not use products, which have been stored longer than 6
      months.
   9. Prior to the mix design review by the Engineer, provide written conformance to the
      specified requirements of the admixture.

F. Preformed Expansion Joint Fillers:
   1. Nonextruding and Resilient Bituminous Types (for exterior use in pavements and
      sidewalks only): ASTM D 1751.
4. Acceptable Manufacturers:
   a. Tamms Industries, Inc.
   b. W.R. Meadows, Inc.
   c. Or approved equal.

G. Curing Materials. Use curing materials that will not stain or affect concrete finish or lessen the concrete strength and comply with the following requirements:
   3. Liquid Membrane-Forming Curing Compound.
      a. Use curing compounds which are nontoxic and free of taste, odor and comply with low V.O.C. requirements.
      b. Where a finish material is to be applied over concrete with architectural finish, provide certification by the product manufacturer stating the curing compound as non-detrimental to the bond of the finish material.
      c. Use material meeting the requirements of ASTM C 309, Type 1.
      d. Acceptable Manufacturers:
         1) L&M Cure; L&M Construction Chemicals, Inc.
         2) Masterkure 200W; Master Builders.
         3) Or approved equal.

H. Epoxy Bonding Compound: A high-modulus, low-viscosity, moisture-insensitive epoxy adhesive having the following properties:
   1. Compressive Properties, ASTM D 695 at 28 days;
      a. Compressive Strength: 8,000 psi. min.
   2. Tensile Properties, ASTM D 638 at 14 days.
      a. Tensile Strength: 4,000 psi. min.
      b. Elongation at Break: One to three percent.
      c. Modulus of Elasticity: $3 \times 10^5$ psi.
   3. Bond Strength, ASTM C 882:
      a. Plastic concrete to hardened concrete at 14 days (moist cure): 1,700 psi. min.
   4. Mixed epoxy resin adhesive shall conform to ASTM C 881, Type II, Grade 2, Class B and C.
   5. Acceptable Manufacturers:
      a. Sikadur 32 Hi-Mod; Sika Corporation.
      b. Euco Epoxy #452 MV or #620; Euclid Chemical Company.
      c. Or approved equal.

I. Epoxy Adhesive (for grouting dowels): A high-modulus, moisture insensitive epoxy adhesive of thick (Gel) consistency having the following properties:
      a. Compressive Strength: 10,000 psi. min. at 28 days.
   2. Tensile Properties, ASTM D 638.
      a. Tensile Strength: 3,000 psi. min. at 14 days.
      b. 14-day, moist cure: 2,000 psi. min.
   3. Bond Strength, ASTM C 882, hardened concrete to hardened concrete:
      a. Mixed epoxy resin adhesive shall conform to ASTM C 881, Type I, Grade 3, Class B and C.
   4. Acceptable Manufacturers:
      a. Sikadur 31 Hi-Mod Gel; Sika Corporation.
      b. Euco Epoxy #452 Gel or #620 Gel; Euclid Chemical Company.
      c. Or approved equal.

J. Vinyl Waterstops: Ribbed type manufactured from virgin polyvinyl chloride plastic compound conforming to U.S. Corps of Engineers CRD-C 572.
   1. Construction Joint: Flat ribbed 6 x 3/8 inch; such as Vinylex Corporation; Cat. No. R6-38.
2. Expansion Joint: Ribbed center buld 9 x 3/8 inch; center buld of 1 ½-inch outside diameter such as Vinylex Corporation. Cat. No. RLB9-38.

3. Acceptable Manufacturers:
   a. Vinylex Corporation (Catalog Nos. as specified above).
   b. Tamms Industries, Inc.
   c. W.R. Meadows, Inc.
   d. Or approved equal.

4. Retro-fit waterstop: 6 x 3/8-inch with 3 3/16-inch T-leg such as Greenstreak Product No. 609 or approved equal.

K. Surface Applied Waterstop: A specially formulated joint sealant, which swells upon contact with water. Provide waterstop packaged in continuous length coils. Material composition as follows:

1. Chloroprene rubber and chloroprene rubber modified to impart hydrophilic properties.
2. Waterstop shall have a coating formulated to inhibit initial expansion due to moisture presence in the fresh concrete.
3. Size: Dual extrusion design; 10 mm by 20 mm.
4. Waterstop shall be secured to hardened concrete with the waterstop manufacturer’s standard adhesive binder.

5. Acceptable Manufacturers:
   a. Greenstreak; Hydrotite VCJ.
   b. ADECA; Ultradeal.
   d. Or equal.

L. Construction Joint Device: Integral galvanized steel formed to tongue and groove profile.

1. For exposed concrete areas, provide plastic joint cap strip that can be removed for placement sealant.
2. Use only in slabs that do not retain water.
3. Acceptable Manufacturers:
   a. Burke Company
   b. Heckman Building Products, Inc.
   c. Or approved equal.

M. Contraction Joint Insert: Two-piece plastic preassembled preformed contraction joint; depth of embedment equal to ¼ of the slab thickness.

1. Acceptable Manufacturers:
   a. Burke Company: Burke Zip Strip.
   c. Or approved equal.

N. Construction and Control Joint Filler for Slab-on-Grade: A two-component epoxy joint filler.

1. Acceptable Manufacturers:
   a. Sika Corporation: Sikadur 51 Sl.
   b. Euclid Chemical Company: Euro 700.
   c. Master Builders: Masterfill 300.
   d. Or approved equal.

2.2 MIXES

A. Selection of Proportions of Normal weight Concrete: ACI 211.1.
B. Proportions of Ingredients: Establish proportions, including water-cement ratio on the basis of either laboratory trial mixture tests or standard deviation analysis, with the materials specified herein.
   1. Laboratory Trial Mixture Test: ACI 301, Section 4.2 and ACI 318, Section 5.3.
   2. Standard Deviation Analysis: ACI 301, Section 4.2 and ACI 318, Section 5.3.

C. Water-Cement Ratio:
   1. Class A Concrete shall have a maximum water-cement ratio of 0.45.
   2. Class B Concrete shall have a maximum water-cement ratio of 0.55.
   3. Proportion Class C Concrete to meet the strength requirement.

D. Slump: Proportion and produce concrete to a slump as indicated below. The slump ranges apply when vibration is used to consolidate the concrete.

<table>
<thead>
<tr>
<th>Types of Construction</th>
<th>Maximum*</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforced foundation walls and footings</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Building Piers</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Pavements and slabs-on-grade</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

* May be increased 1 in. for methods of consolidation other than vibration.

1. Pumped concrete shall have a 5-inch maximum slump, measured prior to pumping.
2. Concrete containing high-range water-reducing admixture shall have an 8-inch maximum slump after admixture is added to concrete with a 2- to 4-inch slump.

2.3 ADMIXTURES

A. Air Entraining: Provide air-entrained concrete for each concrete pour except where indicated otherwise on the Drawings or specified herein. Total air content required as follows:
   1. Maximum-size coarse aggregate, inches: Air content percent by volume:
      1 1/2 5 +/- 1
      3/4 or 1 6 +/- 1

B. Water-Reducing Admixture: Unless high temperatures occur or placing conditions dictate a change, use concrete containing a water-reducing admixture.

C. Water-Reducing and Retarding Admixture: When high temperatures occur or placing conditions dictate, the water-reducing admixture (Type A) may be replaced with a water-reducing and retarding admixture (Type D). Notify the Engineer of such change and submit product data prior to placement of concrete.

D. Water-Reducing and Accelerating Admixture: When low temperatures occur or placing conditions dictate, the water-reducing admixture (Type A) can be replaced with a water-reducing and accelerating admixture. Notify the Engineer of such change and submit product data prior to placement of concrete.

2.4 SOURCE QUALITY CONTROL

A. General Requirement: Provide only Class A concrete in the project except for those cases where indicated otherwise on the Drawings or specified otherwise.
1. Where in-ground encasement of piping is required, provide Class B concrete.
2. Where in-ground encasement of conduit runs is required provide Class B concrete.
3. Where reaction backings and backfilling of over excavated foundation area, foundation voids, and cavities are required, provide Class B concrete.
4. For backfilling of overexcavated foundation area, foundation voids and cavities, provide Class B concrete.

B. Classes of Concrete:
1. Class A: 4,000 psi minimum compressive strength at 28 days; 564 pounds per cubic yard minimum cement content.
2. Class B: 3,000 psi minimum compressive strength at 28 days; 517 pounds per cubic yard minimum cement content.
3. Class C: 2,000 psi minimum compressive strength at 28 days; minimum cement content per cubic yard in accordance with current ready-mix plant standard practice.

PART 3 - EXECUTION

3.1 INSPECTION
A. Inspect work to receive cast-in-place concrete for deficiencies, which would prevent proper execution of the finished work. Do not proceed with placing until such deficiencies are corrected to the satisfaction of the Construction Manager.

3.2 PREPARATION
A. Joints
1. General: Only the locations of critical joints throughout the structures are indicated on the Drawings. Select additional joint locations in walls and footings subject to the Engineer’s approval. Submit requests for approval of joint locations ten days prior to scheduled concrete pours. Do not make concrete pours unless joint locations have been approved by the Engineer.
   a. Place walls and slabs allowing at least two days elapsed time before concrete is placed against an adjacent vertical joint.
2. Construction Joints in Walls and Foundations: Placement of additional joint locations shall meet the following:
   a. Locate such joints to least impair the strength of the structure.
   b. The horizontal length between joints in footings and grade beams shall not exceed 60 feet.
   c. The horizontal length between wall joints shall not exceed 30 feet in a continuous wall. At corners or other intersections of two or more walls, provide a joint in each wall at a distance less than 15 to 20 feet from the intersection point in all directions. Align joints with those placed in footings or offset joints a minimum distance of 5 feet.
   d. When concreting is to be discontinued for more than 45 minutes, install keyways and embed dowels in the concrete before initial hardening. Horizontal joints are not permitted in slabs or footings.
      1) Place dowels in joint one splice length into concrete section and one splice length into next concrete pour.
   e. No exceptions permitted to the above requirements unless written approval is given by the Engineer.
3. Expansion Joints in Walls:
   a. Install where indicated on the Contract Drawings.
   b. Do not extend reinforcing or other embedded metal items through expansion joint except where indicated otherwise on Contract Drawings.
4. Construction Joints in Elevated (Suspended) Formed Slabs: Placement of additional joint locations shall meet the following:
    a. Locate such joints to least impair the strength of the structure.
    b. Space construction joints not greater than 30 feet in each direction, although some adjustments, as approved by the Engineer, may be permitted. Reinforcement shall continue through construction joint.
    c. Joints shall be located within the third point of slab span. Joints in girders should be offset a minimum distance of two times the width of any intersecting beam.
    d. Beams, girders, or slabs supported by columns or walls shall not be cast or erected until concrete in the vertical support members is no longer plastic.
    e. Where concreting is interrupted long enough for concrete to be hardened, install keyway and embed dowels in the concrete before initial hardening.
       1) Place dowels in joint one splice length into slab and one splice length into next concrete pour.
       2) Dowel to be spliced with top and bottom reinforcement; size of dowels to match slab reinforcement.
    f. Provide PVC waterstop in joint where such joints are exposed to liquids, in contact with earth, or subject to weather exposure.

5. Control Joints and Construction Joints in Slab-on-Grade:
    a. Provide control joint spacing at the following maximum spacing unless noted otherwise:
       1) 5 inch slab: 15 feet each way
       2) 6 inch slab: 18 feet each way
       3) 7 inch slab: 21 feet each way
    b. Where contraction joint insert is used, press straight edge cutting tool into wet concrete to part aggregate. Place insert into separation until top of insert lays on surface of wet concrete. Remove top section of insert and float concrete to fill voids adjacent to the insert and finish concrete surface.
    c. Sawcutting is permitted for control joints. Cut concrete as soon as it has hardened sufficiently; complete sawing within 12 hours after placement. Saw a continuous straight slot to a depth of one-fourth the thickness of the slab.
       1) Submit detailed procedure plans for review and acceptance.
    d. Fill all control joints with Control Joint Filler.
    e. Where concreting is interrupted long enough for the placed concrete to harden, construction joint should be provided.

6. Bonding to New Concrete: Bond fresh concrete with hardened previously poured new concrete in accordance with the following:
    a. Roughen and clean hardened concrete to foreign matter and laitance and dampen with water.
    b. Cover the hardened concrete with a heavy coating of grout to approximately ½ inch thickness. Use grout of same material composition and proportions of concrete being poured except coarse aggregate omitted. Use grout with a slump of 6 inches minimum.
    c. Place new concrete on grout before it has attained its initial set.
    d. Other bonding methods must be approved by Engineer prior to use.

B. Embedded Items:
    1. Embedded Pipes and Conduits: Material not harmful to concrete may be permitted to be embedded in concrete upon approval by the Engineer. Items embedded shall satisfy the following:
       a. Maximum outside dimension not greater than one-third the overall thickness of the member in which it is embedded.
       b. Minimum spacing between items not less than 3 widths on center nor 3 inches clear between items.
       c. Item shall not impair strength of member.
       d. Provide 2-inch minimum clearance to face of slab.
e. Cutting, bending, or displacement of reinforcement will not be allowed.

2. Anchor Rod Placement:
   a. Install anchor rods accurately, vertically and horizontally, in the foundations as shown on the Contract Drawings.
   b. Insure rods are firmly held in the correct position and elevation by suitable templates during placement of concrete.
   c. The variation in location of anchor rods and other embedded items from the dimensions shown on the Contract Drawings shall meet the tolerances listed in "Code of Standard Practice for Steel Buildings and Bridges (March 2000)."

3. PVC Waterstops:
   a. Install in all joints where watertightness is required. Provide in joints exposed to liquids, in contact with earth, or subject to weather exposure.
   b. Use continuous lengths without splices where possible.
   c. Provide factory-formed and tested waterstop corners and intersections leaving only straight butt joint splice in field.
   d. Connect all adjoining waterstops including vertical and horizontal runs to provide continuous water barrier.
   e. Splices:
      1) Strength: Not less than 50% of the mechanical strength of the parent section.
      2) Watertightness: Make equal to that of continuous material.
      3) Heat seal adjacent surfaces in accordance with manufacturer’s recommendations using a thermostatically controlled electric source of heat that provides sufficient heat to melt but not to char the material.
   f. Adequately support waterstops to prevent displacement and deformity of the waterstops during concrete pours. Maintain two-inch minimum clearance between waterstop and reinforcing steel.
   g. Center waterstop on joint with one-half of waterstop width to be embedded in concrete on each side of joint at expansion joints. Keep center bulb unembedded.
   h. In substructures and other structures required to be watertight, install waterstops if concreting is discontinued for a sufficient length of time, which in the opinion of the Engineer, may result in seepage cracks in concrete.

4. Surface Applied Waterstop Installation: Install surface applied waterstop at such location indicated on the Drawings.
   a. Install the waterstop in strict accordance with the manufacturer’s installation instructions.

C. Anchoring Reinforcement Dowels into Existing Concrete.
   1. Drill holes for each dowel to the size and depth indicated on the Drawings with carbide tip bit or star bit, core drilling not permitted. Do not drill into or cut or otherwise damage existing reinforcement bars. If existing reinforcement bars are encountered during the drilling operation, relocate the hole to clear the existing reinforcement as directed by the Engineer.
   2. Blow clean each finished hole with an oil free air jet and then flush with a jet of clean water.
   3. Immediately prior to the grouting operation, remove all water from the hole and from the walls of the hole.
   4. Mix and place the epoxy adhesive completely around the dowel bar in strict accordance with the manufacturer’s recommendations, with particular attention given to manufacturer’s specified time limit within which the material must be placed after mixing. Do not retemper grout that has begun to stiffen; discard such grout.

3.3 CONSTRUCTION

A. Production of Concrete
   1. Ready-Mixed Concrete:
a. Batched, mixed, and transported in accordance with ASTM C 94.
b. Add admixtures to the mix in accordance with ACI 301.
c. Plant equipment and facilities conforming to the "Check List for Certification of Ready Mixed Concrete Production Facilities" of the National Ready Mixed Concrete Association.

B. Placing:
   1. General: Conduct placement work in accordance with ACI 304R and such additional requirements as specified herein.
      a. Complete discharge of the concrete within 1½ hours or before the mixing drum has revolved 300 revolutions; whichever comes first, after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates.
   2. Preparation:
      a. Prepare formwork in advance and remove snow, ice, water, and debris from within forms.
      b. Pre-position reinforcement in advance of concrete pours.
      c. Pre-position waterstops, expansion joint materials, anchors and embedded items in advance of concrete pours.
      d. Sprinkle subgrades sufficiently to eliminate water loss from concrete in accordance with ACI 301 Chapter 11.
         1) Subgrade shall be moist with no free water and no muddy or soft spots.
      e. Do not place concrete on frozen surfaces.
      f. Place vapor barrier under slabs-on-grade per requirements of Division 7 Specification Section “Building Insulation.”
   3. Conveying:
      a. Handle concrete from mixer to final deposit rapidly by methods, which will prevent segregation or loss of ingredients to maintain required quality of concrete.
      b. Do not convey concrete through aluminum or aluminum alloy.
      c. Do not place concrete by pumps or other similar devices without prior written approval of the Engineer.
      d. Placing concrete by pumping methods shall conform to the applicable requirements of ACI 304R, Chapter 9, and ACI 304.2R.
   4. Depositing:
      a. Do not drop concrete freely where reinforcing will cause segregation, nor more than four (4) feet.
      b. Deposit concrete in approximately horizontal layers of 12 to 18 inches.
      c. Do not allow concrete to flow laterally more than three feet.
      d. Place concrete at such a rate that concrete which is being integrated with fresh concrete is still plastic.
      e. Do not deposit concrete on concrete, which has hardened sufficiently to cause the formation of seams or planes of weakness within sections.
      f. Do not use concrete, which has partially hardened or has been contaminated by foreign materials.
      g. Do not subject concrete to procedures, which will cause segregation.
      h. Do not place concrete in forms containing standing water.
      i. Make placement within sections continuously to produce monolithic unit.
      j. Do not bend reinforcement out of position when placing concrete.
   5. Consolidation:
      a. Consolidate concrete by vibration, spading, rodding, or other manual methods. Work concrete around reinforcement, embedded items and into corners; eliminate all air or stone pockets and other causes of honeycombing, pitting or planes of weakness.
      b. Use vibration equipment of internal type and not the type attached to forms and reinforcement.
c. Use vibrators capable of transmitting vibration to concrete in frequencies sufficient to provide satisfactory consolidation.
d. Do not leave vibrators in one spot long enough to cause segregation. Remove concrete segregated by vibrator operation.
e. Do not use vibrators to spread concrete.
f. Have sufficient reserve vibration equipment to guard against shutdown of work occasioned by failure of equipment in operation.

6. Cold Weather Concreting: Perform cold weather concrete work in accordance with ACI 306R and the following additional requirements:
   a. Temperatures of the subbase and other surfaces that come in contact with concrete must be above freezing. The subbase and concrete forms surface must be free of snow and ice.
   b. Do not place concrete around any embedment, which has a temperature below freezing.
   c. Provide equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather. Do not use foreign materials or materials containing snow or ice.
      1) When using artificial heat, vent exhaust gases to the outside.

7. Hot Weather Concreting: Perform hot weather concrete work in accordance with ACI 305R and the following additional requirements.
   a. Temperature of concrete delivered at the job-site shall not exceed 90 degrees F.
   b. Cool ingredients before mixing to prevent temperature in excess of 90 degrees F.
   c. Make provisions for windbreaks, shading, fog spraying, sprinkling or wet cover when necessary.

C. Finishing:
1. General: Finish concrete in the various specified manners either to remain as natural concrete or to receive an additional applied finish or material.
   a. Concrete containing ground granulated blast furnace slag may have longer time of set compared to 100 percent Portland Cement concrete.

2. Formed Surfaces: Provide one or more of the following finishes to the surfaces of the concrete after removal of forms. The locations where these finishes are required are listed herein or specified on the Drawings. Allowable surface irregularities are designed as either "abrupt" or "gradual." Check gradual irregularities using 5-foot straightedges.
   a. "Rough Form" finish: Surface may include roughness and irregularities not to exceed 1/2 inch, but tie holes and defects shall be patched.
   b. "Ordinary Wall" finish: Surface that is true and uniform without any conspicuous offsets or bulges. Gradual irregularities not to exceed 1/2 inch and abrupt irregularities not to exceed 1/4 inch.
   c. "Plywood" finish: Similar to the ordinary wall finish. Construct the surface of the forms using 5/8-inch plywood or boards lined with tempered hardboard not less than 3/16 inch thick. Place the plywood or liner sheets in an orderly and symmetrical arrangement using sheets as large as practicable. Do not use sheets showing torn grain, worn edges, patches of holes from previous use, or other defects, which will impair the texture of the concrete surfaces. Remove gradual irregularities exceeding 1/2 inch and abrupt irregularities exceeding 1/8 inch. Completely remove all fins on the surface. Rub all surfaces, which cannot meet these requirements.

3. Unformed Surfaces: In concrete having unformed surfaces, use just sufficient mortar to avoid the necessity for excessive floating. Slope exposed unformed surfaces to provide...
quick, positive drainage and to avoid puddles in low spots. Slope all surfaces exposed to weather 1/4 inch per foot for drainage unless noted otherwise on Drawings.

a. "Floated" Finish: After concrete has been placed, consolidated, struck off, and leveled, do not work further until ready for floating. Begin floating when water sheen has disappeared and when the surface has stiffened sufficiently to permit the operation. During or after first floating, check planeness of surface with a ten-foot straightedge applied at not less than two different angles. Cut down high spots and fill low spots during this procedure to produce a surface with true planes within 1/4 inch in ten feet as determined by a ten foot straightedge placed anywhere on the slab in any direction. Following straightedge checking, refloat slab immediately to a uniform sandy texture.

b. "Steel Trowel" Finish: Obtained by working a floated finish with a steel trowel. First troweling shall produce a smooth surface which is relatively free of defects but which may still show some trowel marks. Perform additional trowelings by hand after the surface has hardened sufficiently. Perform final troweling when a ringing sound is produced as the trowel is moved over the surface. Thoroughly consolidate surface by hand trowel operations. Produce finished surface essentially free of trowel marks, uniform in texture and appearance, with true planes within 1/4 inch in ten feet, as determined by a ten foot straightedge placed anywhere on the slab in any direction.

c. "Broom or Belt" Finish: Immediately after concrete has received a floated finish, give surface a coarse transverse scored texture by drawing a broom or burlap across the surface.

d. "Nonslip" Finish: The surfaces shall be given a "dry shake" application of non-slip aggregate surfacer. The rate of application of such material not to be less than 25 pounds per 100 square feet. Apply in accordance with manufacturer's recommendations.

4. Application for Finishes: Except where the type of finish is indicated on the drawings or under “Special Finish,” all concrete surfaces shall be finished as indicated below.

a. "Rough Form" Finish:
   1) All surfaces to be covered by earth.

b. "Ordinary Wall" Finish:
   1) Interior and exterior wall surfaces not exposed to view.
   2) Undersides of slabs which will be covered by Architectural ceiling.

c. "Plywood" Finish:
   1) All surfaces to be painted.

d. "Rubbed" Finish:
   1) All interior and exterior surfaces exposed to view, which are not to be painted.
   2) All exterior surfaces to a point 6 inches below finished ground.
   3) Equipment pads.

e. "Floated" Finish:
   1) All unformed surfaces unless otherwise specified.

f. "Steel Trowel" Finish:
   1) Tops of exposed walls.

3.4 CURING AND PROTECTION

A. General: Immediately after placement and finishing, protect concrete from premature drying, excessive hot or cold temperatures and mechanical injury. Perform curing by water curing, sheet form curing, or liquid membrane forming methods in accordance with ACI 308. Cure concrete continuously for a minimum of seven days at ambient temperatures above 40 degrees F.

B. Hot Weather Curing: See Hot Weather Concreting this Section.
C. Cold Weather Curing: See Cold Weather Concreting this Section.

D. Application of Liquid Membrane-Forming Curing Compound: Compound shall restrict the loss of water to not more than .039 g/cm² of surface in 72 hours when tested in accordance with ASTM C 156 at the coverage rate recommended by the manufacturer.
1. Submit letter from manufacturer stating coverage rate to meet this restriction in loss of water.
2. Finishing operations must be completed prior to application. Apply compound as soon as the free water on the surface disappears and no water sheen is visible. Surface shall be capable of taking walking workmen without being marred. Apply compound in two (2) applications.
3. Do not apply curing compound to construction joint surfaces. Protect exposed reinforcement during application of curing compound. Water cure those areas not coated with compound.
4. Do not use liquid membrane-forming curing compound when the ambient air temperature during placement and for 24 hours after placement is or will fall below 35 degrees F.
5. Do not use liquid membrane-forming curing compounds on concrete surfaces which will receive later treatments, such as hardeners, special finishes, protective coating, dampproofing, waterproofing, future grout, grout fill, or coatings.

E. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

3.5 FIELD QUALITY CONTROL TESTING

A. Perform the following field tests:
1. Determine slump of the concrete sample for each truckload upon arrival at site and whenever consistency of concrete appears to vary. Test according to ASTM C 143.
2. Determine temperature of concrete sample for each truckload.

3.6 FIELD QUALITY ASSURANCE TESTING

A. General
1. During the entire period when concrete is being placed, testing services shall be provided.
2. Failure to detect defective work will not prevent later rejection when defect is discovered nor shall it obligate the Engineer and Owner for final acceptance.
3. Routine testing of materials shall be the duty of the Quality Assurance Agency engaged by the Owner and will be performed without expense to Contractor.
4. Additional testing of materials because of changes in materials or proportions requested by Contractor and testing required by failure of material to meet specifications shall be at Contractor’s expense.
5. Agency performing testing services shall meet the requirements of ASTM C 1077.

B. Testing Services by Quality Assurance Agency
1. Test check the Contractor’s proposed materials for compliance with the specifications.
2. Review and check test the contractor’s proposed mix design.
3. Secure production samples of materials at plants or stockpiles during the course of the work and test for compliance with the specifications.
4. Conduct strength tests of the concrete in accordance with the following procedures:
   a. The responsible contractor shall secure composite samples in accordance with ASTM C 172. Each strength test shall be obtained from a different batch of concrete on a representative, truly random basis, avoiding any selection of the test batch other than by a number selected at random before commencement of concrete placement. When pumping or pneumatic equipment is used, samples...
shall be taken at the truck and discharge end. Concrete test cylinders shall be made by the responsible contractor under observation of the Quality Assurance Agency. The cylinders shall be molded, and twenty-four (24) hour initial curing provided, in strict compliance with ASTM C 31. Immediately thereafter a responsible representative of the Quality Assurance Agency shall pack them in a sturdy container, furnished by the responsible contractor, and as approved by the Quality Assurance Agency, surround them with wet sand or sawdust, protect them from freezing and transport them to the laboratory where they shall be cured in strict compliance with ASTM C31 until time of test. The cylinders shall be sequentially numbered and a record of date made and date transported to the laboratory. A copy of this record shall be forwarded to the Construction Manager. Unless this record reflects any exceptions, it will be assumed that these procedures have been followed to the mutual satisfaction of the contractor, the testing laboratory, and the Construction Manager. Above-mentioned record shall also include results of slump tests and temperature for each sample.

b. Specimens shall be tested in accordance with ASTM C 39. Two specimens shall be tested at 28 days for acceptance and two shall be tested at 7 days for information. The acceptance test results shall be the average of the strengths of the two specimens tested at 28 days. If one specimen in a test manifests evidence of improper sampling, molding, or testing, it shall be discarded and the strength of the remaining cylinder shall be considered the test result. Should both specimens in a test show any of the above defects, the entire test shall be discarded.

c. Samples for strength tests of each class of concrete (each concrete mix design) shall be taken not less than once a day or less than once for each 100 cu. yd. of concrete or for each 3000 sq. ft. of surface area placed. Not less than five (5) strength tests (4 cylinders per test) shall be conducted for each concrete mix design.

5. The air content of concrete shall be determined on a regular and frequent basis in accordance with ASTM C 231, ASTM C 173, or ASTM C 138.

C. Responsibilities and Duties of Contractor:
1. To facilitate testing services, the Contractor shall:
   a. Advise the Quality Assurance Agency sufficiently in advance of operations to allow for completion of quality tests and for the assignment of personnel.
   b. Provide and maintain for the sole use of the Quality Assurance Agency adequate facilities for safe storage and proper curing of concrete test cylinders on the project site.
   c. Provide containers for transporting concrete test cylinders to the testing laboratory. The containers shall be constructed in accordance with the laboratory’s instructions and shall be the property of the Contractor.

3.7 EVALUATION OF CONCRETE STRENGTH

A. Evaluation of Test Results:
1. Test results for standard molded and standard cured test cylinders shall be evaluated separately for each specified concrete mix design.
2. For evaluation of potential strength and uniformity, each specified mix design shall be represented by at least five tests.

B. Satisfactory Strength Level of Concrete: The strength level of the concrete will be considered satisfactory so long as the average of all sets of three consecutive strength test results equal or exceed the specified strength f’c and no individual strength test result falls below the specified strength f’c by more than 500 psi.

C. Testing of Concrete in Place:
1. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by the Engineer to determine relative strengths at various locations in the structure as an aid in revaluating concrete strength in place or for selecting areas to be cored. Such tests shall not be used as a basis for acceptance or rejections.

2. Core Tests:
   a. Where required, cores at least 2-inches in diameter shall be obtained and tested in accordance with ASTM C 42. If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60 to 80 degrees F, relative humidity less than 60 percent) for 7 days before test and shall be tested dry. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with ASTM C 42.
   b. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores shall be determined by the Engineer so as to least impair the strength of the structure. If, before testing, one or more of the cores shows evidence of having been damaged subsequent to or during removal from the structure, it shall be replaced.
   c. Concrete in the area represented by a core test will be considered adequate if the average strength of the cores is equal to at least 85 percent of, and if no single core is less than 75 percent of, the specified strength f’c.
   d. Core holes shall be filled solid with low slump concrete.

3.8 ACCEPTANCE OF STRUCTURE

A. General
   1. Completed concrete work which meets all applicable requirements will be accepted without qualification.
   2. Completed concrete work which fails to meet one or more requirements but which has been repaired to being it into compliance will be accepted without qualification.
   3. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these specifications.

B. Concrete Compressive Strength: If the concrete fails to meet the compressive strength requirements additional curing as specified by the Engineer may be required and modifications including change in the concrete mix design may be required for the remaining concrete work, all at the expense of the Contractor.

C. Dimensional Tolerances:
   1. Formed surfaces resulting in concrete outlines smaller than amount exceeding the requirements permitted by the tolerances of ACI 117 shall be considered deficient in strength and subject to the provisions of Paragraph 3.8E.
   2. Formed surfaces resulting in concrete outlined larger than required, by an amount exceeding the requirements of ACI 117 may be rejected and the excess material shall be subject to removal. If removal of the excess material is permitted, it shall be accomplished in such a manner as to maintain the strength of the section and to meet all other applicable requirements of function and appearance.
   3. Concrete members cast in the wrong location may be rejected if the strength, appearance, or function of the structure is adversely affected or the misplaced items interfere with other construction.
   4. Inaccurately formed concrete surfaces exceeding the requirements of ACI 117 and which are exposed to view may be rejected. Section shall be repaired or removed and replaced if required.
   5. Finished flatwork exceeding the allowable tolerances may be repaired provided that strength or appearance is not adversely affected. High spots may be removed with a...
terrazzo grinder, low spots filled in with an approved patching compound, or other remedial measure performed as permitted.

D. Appearances:
1. Concrete exposed to view with defects which adversely affect the appearance of the specified finish may be repaired, if possible. If, in the opinion of the Engineer, the defect cannot be repaired, the concrete may be accepted or rejected as provided in these specifications.
2. Concrete not exposed to view is not subject to rejection for defective appearance.

E. Strength of Structure – Potential Deficiency:
1. The strength of the structure in place will be considered potentially deficient if it fails to comply with any requirements, which control the strength of the structure, including but not necessarily limited to the following conditions:
   a. Low concrete strength.
   b. Reinforcing steel size, quantity, strength, position, or arrangement at variance, which the requirements of the contract documents.
   c. Concrete, which differs from the required dimensions or location in such a manner as to reduce the strength.
   d. Curing less than that specified.
   e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
   f. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
   g. Poor workmanship likely to result in deficient strength.
2. Structural analysis and/or additional testing may be required when the strength of the structure is considered potentially deficient.
3. Core tests may be required when the strength of the concrete in place is considered potentially deficient.

F. Failure to Meet Requirements:
1. Owner and the Engineer reserve the right to reject any or all items which do not meet the requirements of the plans and specifications. The Contractor will replace these items veering all expenses in connection with such replacements.
2. If strength tests of concrete fail to meet the minimum requirements as specified herein, the concrete represented by such tests shall be considered questionable and shall be subject to further testing at the expense of the Contractor.
3. Additional tests of questionable concrete shall be conducted in accordance with ASTM C 42 as deemed necessary by the Owner and/or the Engineer.
4. Additional tests of the hardened concrete may be required by the Owner and/or the Engineer, if in their opinion, there is cause for concern over the adequacy of the structure regardless of the results of any previous tests. If initial tests requirements had been met, the Contractor shall not be required to bear the costs of such additional tests unless their results confirm the concrete in place is deficient.
5. If core tests fail to demonstrate strengths adequate for the intended purpose of the member or members in question or are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be required. The results shall be evaluated in accordance with ACI 318.
6. Concrete work judged inadequate by the Engineer and/or Construction Manager based on structural analysis or by results of a load test shall be reinforced with additional construction if so directed by the Engineer or shall be replaced, at the Contractor’s expense.
7. Except as provided earlier in this Paragraph, the Contractor shall pay all costs incurred in providing the additional testing and/or analysis required by this section.
3.9 REPAIR OF DEFECTIVE CONCRETE

A. The Engineer will determine the extent and manner of action to be taken for the correction of defective concrete as may be revealed by surface defects or otherwise.
   1. Prior to repair of defects, Contractor shall submit proposed material and repair methods to the Engineer for approval.
   2. Obtain approval from the Engineer before performing repair work other than the removal of imperfect texture, filling pin holes and insert holes.

B. As soon as the forms have been stripped and the concrete surfaces exposed, remove fins and other projections, fill recesses left by the removal of form ties, and repair surface defects which do not impair structural strength. Clean all exposed concrete surfaces and adjoining word stained by leakage of concrete to the satisfaction of the Construction Manager.

C. Hammer jack tie holes and other small cavities with a stiff mortar of the same material, but somewhat leaner that that in the concrete. Clean the cavity and the area wetted before mortar is placed.

D. Repair and patch defective areas with cement mortar of mix proportions and materials identical to those used in the surrounding concrete. Produce a finish on the patch that is indistinguishable from the surrounding concrete.

E. Where the honeycomb or voids are not excessive and repairs are authorized by the Engineer, outline removal area in a square shape with a ½- to ¾-inch deep saw cut and chip remaining at depth to sound solid concrete with a depth not less than 2-inches. When chipping is necessary, make edges perpendicular to concrete surface, or slightly undercut to provide a key at the edge of the patch. Before placing cement mortar, thoroughly clean, dampen, and brush coat area to be patched with neat cement grout. Other patching materials may be used if accepted by Engineer in writing prior to start of repair work. The patch should be kept damp for seven days at a temperature above 50 degrees.

END OF SECTION 03 30 53
**FINAL CONCRETE MIX DESIGN SUBMITTAL FORM**

(One for each required mix design)

**PROJECT:** __________________ Location: ____________________________________

General Contractor: ___________________________________________________________

Mix design no.: ________________ Design strength: ______________________________

**USE (Describe):** ___________________________________________________________

Mix Design Preparation: Based on Standard Deviation Analysis: ____________________

(check one) or Based on Trial Mixture Test Data: _____________________

**MATERIALS:**

Aggregates: (Provide size, type, source, specification)

Coarse: _______________________________________________________________________

Fine: _________________________________________________________________________

Cement Type/Source: _______________________________________________________________________

Admixtures: (Provide product, manufacturer)

Water Reducer: _______________________________________________________________________

Air Entraining: _______________________________________________________________________

Accelerator: _________________________________________________________________________

Other: _____________________________________________________________________________

**CONCRETE PROPERTIES**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water/Cement Ratio</td>
<td>______________</td>
</tr>
<tr>
<td>Slump (inches)</td>
<td>______________</td>
</tr>
<tr>
<td>Entrained Air (%)</td>
<td>______________</td>
</tr>
<tr>
<td>Density (pcf)</td>
<td>______________</td>
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</table>

**SPECIFIC GRAVITIES**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
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<td>Fine Aggregate</td>
<td>__________</td>
</tr>
<tr>
<td>Coarse Aggregate</td>
<td>__________</td>
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**ADMIXTURES**

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<tr>
<th>Admixture</th>
<th>Amount per 100# cement</th>
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<tbody>
<tr>
<td>Accelerator</td>
<td>__________ oz.</td>
</tr>
<tr>
<td>W. R.</td>
<td>__________ oz.</td>
</tr>
<tr>
<td>A. E.</td>
<td>__________ oz.</td>
</tr>
<tr>
<td>Other</td>
<td>__________ oz.</td>
</tr>
</tbody>
</table>

**MIX PROPORTIONS**

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight (lbs)</th>
<th>Absolute Volume (cubic feet)</th>
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</thead>
<tbody>
<tr>
<td>Cement</td>
<td>__________</td>
<td>______________</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td>__________</td>
<td>______________</td>
</tr>
<tr>
<td>Coarse Aggregate</td>
<td>__________</td>
<td>______________</td>
</tr>
<tr>
<td>Water</td>
<td>__________</td>
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</tr>
<tr>
<td>Entrained Air</td>
<td>__________</td>
<td>______________</td>
</tr>
<tr>
<td>Other</td>
<td>__________</td>
<td>______________</td>
</tr>
</tbody>
</table>

**TOTAL** __________  ______________
**TEST RESULTS SUBMITTAL FORM**

**METHOD 1 - STANDARD DEVIATION ANALYSIS (ACI 318-02 SECTION 5.3.2.1):**

Number of Test Cylinders Evaluated: __________  Standard Deviation: __________

(Attach Copy of All Test Results)

Mix Designs Proportioned to Achieve Both of the Following:

\[
\begin{align*}
  f'_{cr} &= f'_c + 1.34s = \text{__________ psi} \\
  f'_{cr} &= f'_c + 2.33s - 500 = \text{__________ psi} \\
  \text{Actual } f'_c &= \text{__________ psi (} \leq f'_{cr}) \\
  \text{Slump} &= \text{__________ Air Content} = \text{__________ %}
\end{align*}
\]

**METHOD 2 - TRIAL MIXTURE TEST DATA (ACI 318-02 SECTION 5.3.2.2):**

<table>
<thead>
<tr>
<th>Age (days)</th>
<th>Mix 1 (comp. str.)</th>
<th>Mix 2 (comp. str.)</th>
<th>Mix 3 (comp. str.)</th>
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<tbody>
<tr>
<td>7</td>
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<td></td>
<td></td>
</tr>
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<td>28</td>
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<tr>
<td>28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28-day avg.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mix Design Proportioned to Achieve the Following:

\[
\begin{align*}
  f'_{cr} &= f'_c + 1200 \text{ psi (for } f'_c \leq 5000 \text{ psi)} \\
  \text{or} \quad f'_{cr} &= f'_c + 1400 \text{ psi (for } f'_c > 5000 \text{ psi)} \\
  \text{Slump} &= \text{__________ in. Air Content} = \text{__________ %}
\end{align*}
\]

**REMARKS:**

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Note: Fill in all blank spaces. Use -0- (zero) or N.A. (not applicable). See Design and Control of Concrete Mixtures, Portland Cement Association, for assistance in filling out this form.

**SUBMITTED BY:**

Ready-Mix Supplier: Name ________________________________________________
Address ________________________________________________________________
Phone Number __________________________________________________________
SECTION 03 60 00 - GROUTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section specifies the grouts for the individual grouting requirements stated in other Sections of the Specifications and where indicated on the Drawings.

1.2 RELATED SECTIONS

A. Section 03 30 53: Miscellaneous Cast-in-Place Concrete.

1.3 REFERENCES

A. American Concrete Institute (ACI):
   1. ACI 305R, Hot Weather Concreting.
   2. ACI 306R, Cold Weather Concreting.

B. American Society for Testing and Materials (ASTM):
   1. ASTM C 33; Standard Specification for Concrete Aggregate.
   2. ASTM C 109; Test Method for Compressive Strength of Hydraulic Cement Mortars (Using two-inch or 50-mm Cube Specimens).
   5. ASTM C 596; Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
   7. ASTM C 1107; Specification for Packaged Dry, Hydraulic Cement Grout (Non-Shrink).

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive product data and current specifications covering named manufactured products specified in this Section. Include placing instructions.
   1. Non-Shrink Grout.

B. Design Mix: Prior to production of grout mix, submit for approval all mix designs proposed for project.

C. Test Report: Submit test reports specified within this specification.

1.5 QUALITY REQUIREMENTS

A. Grout Performance Qualifications: Furnish the grout manufacturer's current independent laboratory test results indicating the grout as non-shrink from time of placement as conforming to the Following:
   1. Early height change of 0.0% to 4.0%, according to ASTM C 827.
   2. Hardened height change of 0.0% to 0.3% according to ASTM C 1090.
   3. Indicating 4,000 psi strength developed with a trowelable mix within 24 hours.
   4. Indicating placement time based on initial set of not less than 60 minutes, according to ASTM C 191.
1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Handling: Provide protective covering over materials to prevent moisture damage and contamination of grout materials during delivery and handling.

B. Storage: Store grout materials in undamaged condition with seals and labels intact as packaged by the manufacturer.

1.7 PROJECT CONDITIONS

A. Environmental Requirements: Protect against high and low temperatures and unfavorable environmental conditions in accordance with American Concrete Institute standards for placement of concrete.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Non-Shrink Non-Metallic Grout:
   1. A factory premixed material containing no corrosive irons, aluminums, chemicals, or gypsums.
      a. Provide a ready-mix type of grout requiring only the addition of water.
      b. Do not add other materials to the grout.
      c. For grout applications not in contact with sewage, provide grout manufactured using Type I (Normal) cement as specified in Section 03 30 53.
      d. For grout applications in contact with sewage, provide grout manufactured using Type II (Sulfate Resistant) cement as specified in Section 03 30 53.

2. Acceptable manufacturers for non-shrink non-metallic grout include the following:
   a. Five Star Products, Inc.
   b. US Grout, LLC.
   c. Or approved equal.

B. Portland Cement:
   1. Portland Cement conforming to the requirements of ASTM C 150 Type I or Type II as specified.
      a. Provide Type II (sulfate resistant) cement for applications in contact with sewage.

C. Aggregates:
   1. Fine aggregate conforming to the material quality requirements of ASTM C 33.

2.2 MIXES

A. Neat Cement:
   1. Use Type I Portland Cement and water in the same proportions specified in Section 03 30 53 for Class A cast-in-place concrete, but omit the fine and coarse aggregates from the mix.

B. Sand/Cement Grout:
   1. Proportion the proposed design mix using mixture of Portland Cement, fine aggregate, and water in the same proportion specified for Class A cast-in-place concrete in Section 03 30 53.
PART 3 - EXECUTION

3.1 PREPARATION

A. Preparation of Surface: Clean surfaces to be grouted to be free of oil, grease, laitance, dirt, and other contaminants. Remove loose material. Remove rust, paint, and oil from metal components in contact with grout.
   1. Additional Preparation: Perform additional surface preparation in accordance with manufacturer's instructions.

B. Formwork: Use forming procedures that allow proper and complete placement of grout.
   1. Pre-treat wood forms with forming oils so that they do not absorb moisture.
   2. Anchor support elements of formwork so no movement is possible. Remove supports only after grout has hardened.

C. Grout Mixing: Use power-operated mechanical mixer of sufficient capacity to carry out batch mixing without interruption.
   1. Mix Non-Shrink Grout in accordance with manufacturer's instructions.
   2. Mix Sand/Cement Grout in accordance with requirements specified for mixing Class A concrete in Section 03300.

3.2 INSTALLATION

A. Sand/Cement Grout:
   1. After the surface has been prepared as specified in Paragraph 3.1B, first saturate the surface to be grouted with water, remove any excess water, and then brush on a coat of Neat Cement.
      a. Place the grout while the Neat Cement is wet.
   2. Place the grout in a single pour, and consolidate and finish the grout with a steel trowel.
      a. In vertical applications, place grout in monolithic pours.
   3. Cure and seal the grout in accordance with ACI 308.

B. Non-Shrink Non-Metallic Grout:
   1. Place non-shrink non-metallic grout in exposed and unexposed areas at locations indicated on the Contract Drawings.
   2. Mix and place non-shrink non-metallic grout in accordance with the manufacturer’s published instructions.

3.3 FIELD QUALITY CONTROL

A. Remove formwork supports only after the grout has hardened.

B. Protect grout against high and low temperatures and unfavorable environmental conditions in accordance with the requirements of ACI 305R, ACI 306R, and ACI 306.1 for placement of concrete until it has cured.

END OF SECTION 03 60 00
SECTION 03 72 00 - REPAIR OF EXISTING CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The work specified in this section consists of repairs to portions of the existing concrete. Types of repair to be made include but are not limited to:
   1. Repair of surface spalls and delaminations on existing concrete.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer’s descriptive product data and current specifications for materials proposed for the work of this section. Provide a certification stating the repair materials meet the specified requirements.

B. Repair Sites: Submit sketches of repair sites indicating type of repair, location, and dimensions.

C. Repair Program: Submit written procedures for required concrete repair, including protection plan for surrounding structure and utilities.

D. Qualifications: Submit written certificate stating Contractor has minimum five years of experience in comparable concrete repair.

1.3 QUALITY ASSURANCE

A. Concrete Repair Product Manufacturer Qualifications: The manufacturer of the specified product shall have in existence, for a minimum of 10 years, a program of training, certifying, and technically supporting a nationally organized Approved Contractor Program with annual re-certification of its participants.

B. Contractor Qualifications: Contractor shall have at least five years of experience in comparable concrete repair services. The Contractor shall also be an Approved Contractor of the manufacturer of the specified product, who has completed a program of instruction in the use of the specified material, and shall provide a notarized certification from the manufacturer attesting to their Approved Contractor status.
   1. Contractors shall provide the Engineer with two job references where they have successfully repaired existing concrete with the specified product.

C. Manufacturer’s Representative Services: The Contractor shall arrange for, and provide, the services of the product manufacturer’s technical representative to be on-site during the start up repair operation.
   1. Services shall include detailed instructions to the Contractor’s personnel on the use of the concrete repair material.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Handling: Deliver the specified product in original, unopened containers with the manufacturer’s name, labels, product identification, and batch numbers.

B. Storage: Store the specified product as recommended by the manufacturer.
1.5 PROJECT CONDITIONS

A. The Contractor, in conjunction with the Engineer, shall inspect the existing concrete surfaces and determine the location, limits, and type of repair required. The Contractor shall then develop and submit sketches of repair sites called for in 1.03, B. above. Repairs of deteriorated concrete specified by quantities listed on the Contract Drawings shall be performed by the Contractor and any cost incurred due to deviation from the quantity shall be negotiated at the supplemental unit price. Repair of concrete required due to demolition of adjacent concrete or embedments shall be included in the Contract Bid price and shall be performed at no additional cost to the Owner. The Contractor shall not perform any repair work without prior approval of the Engineer.

B. Reinforcement may be encountered within the repair region.

C. When using abrasive blasting equipment, shield all work for the protection of those portions of the facility which are still in operation.

D. Precautions shall be taken to protect surrounding items from damage related to concrete restoration work.

E. Maintain environmental conditions (such as temperature and ventilation) within limits recommended by manufacturer.

PART 2 - PRODUCTS

2.1 CEMENTITIOUS POLYMER MORTARS

A. Polymer Repair Mortar:
   1. Repair of Horizontal Surfaces:
      a. Polymer-modified cementitious, 2-component, trowel-grade patching mortar such as SikaTop 122 Plus as manufactured by Sika Corporation.
   2. Repair of Vertical and Overhead Surfaces:
      a. Polymer-modified, cementitious, 2-component, fast-setting mortar such as SikaTop 123 Plus, Gel Mortar, as manufactured by Sika Corporation.

B. Anti-Corrosion Coating:
   1. Epoxy-modified cementitious product formulated as a bonding agent and anti-corrosion coating such as Sika Armatec 110 EpoCem as manufactured by Sika Corporation.

2.2 MATERIAL SUBSTITUTIONS

A. The use of other than the specified products will be considered providing the contractor requests their use in writing to the Engineer. This request shall also be accompanied by (a) a certificate of compliance from an approved independent testing laboratory the proposed substitute products meet or exceed the specified performance criteria, tested in accordance with the specified test standards; and (b) documented proof the proposed substitute products have a five year proven record of performance, confirmed by actual field tests and five successful installations that the Engineer can investigate.
PART 3 - EXECUTION

3.1 INSPECTION

A. In the presence of the Engineer, inspect concrete surfaces under work of this section to determine the exact limits and location of the areas to be repaired.

3.2 SURFACE PREPARATION

A. Make a one-inch deep sawcut around the perimeter of repair area.

B. Remove spalled, scaled, loose, and deteriorated concrete. Use maximum 30# size pneumatic hammer or other approved method to remove deteriorated concrete resulting in substrate surface profile of ± 1/16 inch.

3.3 REINFORCEMENT CLEANING AND PROTECTION

A. Reinforcing steel with active corrosion shall be mechanically cleaned to remove all traces of rust and contaminants.

B. After cleaning of reinforcing steel, verify the amount of section lost of bar and contact Engineer if lost is more than 20% of original area. Engineer will provide details based on conditions reported.

C. Protect the reinforcing steel with the application of an anti-corrosion coating in accordance with manufacturer’s instructions.

3.4 APPLICATION

A. Maintain a clean condition substrate without dirt, dust, and other contaminants that may interfere with adhesion.

B. Follow manufacturer’s application instructions for substrate preparation, material placement, and material curing.

C. Place patching compound in a manner to assure all corners and gaps under reinforcing steel is completely filled and compacted.

3.5 CLEANING

A. Leave finished work in a clean condition without evidence of spillover onto adjacent areas.

END OF SECTION 03 72 00
SECTION 04 10 00 - MASONRY CLEANING  [C]

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Removing plant growth.
   2. Cleaning of existing exterior brick masonry and stone trim.
      a. Stone trim shall be defined as all exterior stone including, but not limited to, limestone cornices, wall caps, free-standing columns, attached pilasters, sills keystones, veneer, watercourse trim, and attached site walls. [C]
      b. Cleaning is to be limited to the Henderson North Building, including the complete building exterior and all attached site walls. [C]

B. Related Sections:
   2. Division 04 Section “Unit Masonry” for new masonry work.

1.2 REFERENCES

A. Government Printing Office
   1. GPO Preservation Brief 1 - The Cleaning and Waterproof Coating of Masonry Buildings.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Detail scaffolding installation and indicate points and types of attachment to existing structure required to support temporary facilities.

B. Product Data: Submit data on cleaning products.
   1. Provide additional record copies of final approved cleaning product data for PSU Office of Environmental Health and Safety for their review for hazardous materials.

C. Samples:
   1. Submit two containers of each cleaning product in manufacturer’s standard packaging.

D. Manufacturer’s Installation Instructions: Submit installation and application procedures for products selected for use. Include the following:
   1. Manufacturer’s standard installation instructions.
   2. Precautions for protecting adjacent materials.
   3. Procedures for containing waste materials resulting from restoration operations.
   4. Site cleanup instructions.

E. Manufacturer’s Certificates:
   1. Submit test reports and certifications substantiating that products comply with specified requirements.

F. Manufacturer and Contractor Qualification Data: Submit list of minimum five completed projects of similar size and cleaning procedures. Include the following:
   1. Project names and addresses. Include one project completed for minimum 10 years.
   2. Names, addresses, telephone number, and contact name for architects and owners.
   3. Description of restoration and cleaning products and methods used.
G. Masonry Cleaning Plan: Describe in detail the materials, methods, equipment, and sequence of operations to be used for cleaning work. Include the following:
   1. Procedures for protecting surrounding materials and Project site.
   2. Description of materials required that are not specified.

1.4 QUALITY ASSURANCE

A. Perform cleaning in accordance with GPO Preservation Brief 1.

B. Single Source: Obtain cleaning materials for masonry restoration from a single source for each type of material.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience manufacturing products for restoration and cleaning historic masonry structures.

B. Masonry Cleaning Contractor: Company specializing in performing Work of this section with minimum ten years documented experience in cleaning masonry structures.

1.6 MOCKUP

A. Clean wall panel, minimum 20 sq ft each to determine extent of cleaning, cleaning methods, and cleaning products. Clean wall panels including each existing exterior veneer material or provide separate wall panels for brick and limestone. Repeat, using different cleaning methods, to produce minimum three different panels, until acceptable.
   1. Provide minimum one panel for each proposed detergent, chemical, and power washing cleaning method.
   2. When requested by Architect, provide additional mockup panels using different detergent or chemical products to improve cleaning effectiveness or reduce effect of cleaning on masonry surfaces.
   3. Architect will select mockup panel that produces most effective cleaning with least effect on brick, stone, and mortar joints representing cleaning methods to be used for remainder of building.

B. Locate mockup panels where directed by Architect.

C. Accepted mockups will become standard for work of this section.

1.7 PRE-INSTALLATION MEETING

A. Convene minimum one week prior to commencing Work of this section.

B. Review cleaning procedures including protection of surrounding materials and site.

C. Review sequence of Work and interface with work of other sections.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store cleaning materials in manufacturer's packaging.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Clean masonry only when:
1. Ambient air temperature is between 45 degrees F and 80 degrees F and is predicted to remain within this range for 7 days after performing cleaning work.
2. Wind cannot carry cleaning solutions to unprotected or previously cleaned areas.

1.10 SEQUENCING

B. Ensure masonry restoration is completed and accepted by Architect before beginning masonry cleaning operations.

C. Perform masonry cleaning work in the following sequence:
   1. Remove plant growth.
   2. Remove paint from masonry surfaces.
   3. Clean masonry surfaces.

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS

B. Manufacturers:
   1. Diedrich Technologies, Inc.
   2. Dominion Restoration, Inc.
   3. Hydrochemical Techniques, Inc.
   4. ProSoCo, Inc.

C. Nonacidic Gel Cleaner: Gel containing detergents and chelating agents formulated for cleaning masonry surfaces; pH between 6 and 9.
   1. Sure Klean 942 Masonry Cleaner; ProSoCo, Inc.

D. Nonacidic liquid Cleaner: liquid cleaner formulated for removing mold, mildew, and other organic soilings from stone and brick.
   1. Bio-Cleanse; Dominion Restoration, Inc.

E. Alkaline Prewash Cleaner: Cleaner for prewash applications used only where followed by an acidic cleaner of type indicated for afterwash.
   1. Sure Klean 766 Prewash; ProSoCo, Inc.

F. Mild Acidic Cleaner: Cleaner containing no hydrochloric, hydrofluoric, or sulfuric acid; chlorine bleaches; or caustic soda.
   1. DR--60 Stone and Masonry Cleaner; Dominion Restoration, Inc.
   2. Sure Klean Light-Duly Restoration Cleaner; ProSoCo, Inc.

G. Acidic Cleaner: Masonry restoration cleaner composed of hydrofluoric acid blended with other acids and wetting agents.
   1. Diedrich 101G Granite, Tema Cotta, and Brick Cleaner; Diedrich Technologies, Inc.
   2. Hydroclean Brick, Granite, Sandstone and Tema Cotta Cleaner (HT-626); Hydrochemical Techniques, Inc.
   3. Sure Klean Heavy-Duly Restoration Cleaner; ProSoCo, Inc.
   4. Sure Klean 1028 Restoration Cleaner; ProSoCo, Inc.
   5. Sure Klean Restoration Cleaner; ProSoCo, Inc.

H. One-Part limestone Cleaner: One-part acidic formulation for cleaning limestone
   1. Hydroclean Limestone and Marble Cleaner and Brightener (HT -907); Hydrochemical Techniques, Inc.
   2. Sure Klean Limestone Restorer; ProSoCo, Inc.
I. Two-Part Limestone Gleaner: Two part system consisting of an alkaline cleaner for prewash and an acid neutralizer for afterwash
   1. Diedrich Limestone Cleaner Prerinse (707) and Neutralizer After-Rinse (707N); Diedrich Technologies, Inc.
   2. Hydroclean Limestone and Marble Precleaner (HT-704) and Hydroclean Limestone and Marble Cleaner and Brightener (HT-907); Hydrochemical Techniques, Inc.
   3. Sure Klean Limestone Prewash and Afterwash; ProSoCo, Inc.

J. Alkaline Paint Remover: Paste formulation for removing paint coatings from masonry.
   1. Diedrich 4041606/606X Paint Remover; Diedrich Technologies, Inc.
   2. Hydroclean Heavy Duty Paint Remover (HT-716); Hydrochemical Techniques, Inc.
   3. Enviro Strip #1; ProSoCo, Inc.
   4. Enviro Strip #2; ProSoCo, Inc.
   5. 1217 Poultice/Paint Stripper; ProSoCo, Inc.
   6. Sure Klean Heavy-Duty Paint Stripper; ProSoCo, Inc.

K. Solvent-Type Paint Remover: Thixotropic, water-rinsable solvent formulation for removing paint coatings from masonry.
   1. Diedrich 505 Special Coatings Stripper; Diedrich Technologies, Inc.
   2. Diedrich 505X Dry Strip; Diedrich Technologies, Inc.
   3. Dominion Multi-Layer Paint & Graffiti Remover; Dominion Restoration, Inc.
   4. Hydroclean Solvent Paint Remover (HT-300); Hydrochemical Techniques, Inc.
   5. Non-Methylene Chloride Paint Stripper; ProSoCo, Inc.
   6. Sure Klean 509 Paint Stripper; ProSoCo, Inc.
   7. Sure Klean 859 Paint Stripper; ProSoCo, Inc.
   8. Sure Klean 940 Paint Stripper; ProSoCo, Inc.

L. Water for Cleaning: Potable.

2.2 CHEMICAL CLEANING SOLUTIONS

A. Dilute chemical cleaners with water to produce solutions of concentration recommended by chemical cleaner manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify surfaces to be cleaned are ready for work of this section.

B. Verify mortar joints have been repointed as required to produce tight, compact joint surface.

C. Verify sealant joints have been repaired or replaced as required to produce joints fully adhered to joint substrates and without gaps or voids in joint surface.

3.2 PREPARATION

A. Protect elements surrounding work of this section from damage or disfiguration.

B. Protect people, motor vehicles, surrounding surfaces of building being cleaned, site, plants, and surrounding buildings from damage resulting from cleaning work.
   1. Prevent cleaning solutions from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be damaged.
2. Erect temporary protection covers over pedestrian walkways remaining open and at points of entrance and exit for persons and vehicles that must remain in operation during course of masonry cleaning work

C. Carefully remove and store fixtures, fittings, finishing hardware, accessories that may be damaged by cleaning operations.

D. Provide facilities to collect, neutralize and dispose of cleaning operation wastes.

3.3 CLEANING MASONRY, GENERAL

A. Clean masonry from top to bottom from one end of each elevation to opposite end.

B. Use only Cleaning methods for each masonry material and location identical to methods used for approved mockup.
   1. Use natural-fiber brushes only.
   2. Use spray equipment that provides controlled volume and pressure at spray tip. Adjust pressure and volume to ensure that cleaning methods do not damage masonry.
   3. Apply chemical cleaner with low-pressure spray, equipped with a cone-shaped spray tip.
   4. For water spray application, use a fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.

C. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces.

D. Completely remove plant, moss, and shrub growth from masonry surfaces. Carefully remove plants, creepers, and vegetation by cutting at roots and allowing to dry as long as possible before removal.
   1. Apply root-killing material to plant roots according to manufacturers written instructions. Do not apply materials to plants that are to remain.

E. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting.
   1. Apply rinse water in quantities to keep masonry surfaces wet below point of rinsing and to ensure residue is removed from entire masonry surface.

3.4 CLEANING EXISTING MASONRY

A. Clean existing masonry by one or more of the following methods, listed from least to most aggressive, as indicated in approved cleaning plan. Select least aggressive cleaning method available to effectively clean each type of masonry for existing conditions. Demonstrate effectiveness of selected cleaning methods with mockup. Adjust cleaning plan and selected cleaning methods based on mockup cleaning. Use application pressures determined during mockup cleaning.
   1. Cold-water wash.
   2. Warm-Water Wash.
   3. Detergent Cleaning.
   4. Nonacidic Liquid Chemical Cleaning.
   5. Nonacidic Gel Chemical Cleaning.
   7. Acidic Chemical Cleaning.

B. Remove paint from existing masonry by one or more of the following methods, listed from least to most aggressive, as indicated in approved cleaning plan. Select least aggressive cleaning
method available to effectively remove existing paint from each type of masonry. Demonstrate effectiveness of selected cleaning methods with mockup. Adjust cleaning plan and selected cleaning methods based on mockup cleaning.

1. Alkaline Paint Remover.
2. Solvent-Type Paint Remover.

C. Apply cleaning solutions and paint removers in accordance with manufacturer's instructions and approved cleaning plan.

D. Clean surfaces and remove large particles with wood scrapers or non-ferrous wire brush.

E. Spray or brush coat masonry with cleaning solution.

F. Provide second application when required by approved mockup.

G. Allow sufficient time for solution to remain on masonry and agitate with soft fiber brush.

H. Rinse from bottom up with potable water applied at 400 to 600 psi and at rate of 4 to 6 gal/min.

I. Allow masonry to dry.

J. Request inspection of cleaned masonry by Architect.

K. Repeat cleaning operations and adjust cleaning plan when required by Architect to match approved mockup.

3.5 WATER REPELLENT TREATMENT

A. Water Repellent Treatment At the completion of the cleaning operations, apply a water repellent treatment using a non-staining water repellent, gum resin based solution.

1. Silicone or silicone based materials will not be acceptable.
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Face brick.
3. Decorative CMU veneer.
4. Mortar and grout.
5. Steel reinforcing bars.
7. Ties and anchors.
8. Concealed lintel system for brick veneer.
9. Embedded flashing.
10. Miscellaneous masonry accessories.
11. Cavity-wall insulation.
12. Through-wall flashing for stone masonry is included in this section, but shall also comply with the requirements of Division 7 section “Flashing and Sheet Metal.”

B. Related Sections:

1. Division 02 Sections "Structure Demolition" and “Selective Structure Demolition” for salvage of existing face brick to be reused.
2. Division 03 Section "Cast-in-Place Concrete" for installing dovetail slots for masonry anchors.
3. Division 05 Section "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
4. Division 05 Section "Metal Fabrications" for furnishing steel lintels and shelf angles for unit masonry.
5. Division 07 Section "Sheet Metal Flashing and Trim" for furnishing manufactured reglets installed in masonry joints.
6. Division 32 Section "Unit Paving" for exterior unit masonry paving.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).
B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

A. All concrete work shall conform to ACI 530/ASCE 5 “Building Code Requirements for Masonry Structures” except as noted otherwise.
B. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.

   1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

   1. Product Certificates for Credit MR 5.1 and Credit MR 5.2: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

C. Shop Drawings: For the following:

   1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
   2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
   4. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

D. Samples for Initial Selection:

   1. Face brick, in the form of straps of five or more bricks.
   2. Colored mortar.
   3. Weep holes/vents.

E. Samples for Verification: For each type and color of the following:

   1. Exposed CMUs.
   2. Face brick, in the form of straps of five or more bricks.
   3. Special brick shapes.
   4. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.
   5. Weep holes and vents.
   6. Accessories embedded in masonry.

F. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

   1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

G. Qualification Data: For testing agency.

H. Material Certificates: For each type and size of the following:

   1. Masonry units.
a. Include material test reports substantiating compliance with requirements.
b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
c. For exposed brick, include test report for efflorescence according to ASTM C 67.
d. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and thawing per ASTM C 67.
e. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include brand, type, and name of manufacturer.
3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
4. Grout mixes. Include description of type and proportions of ingredients.
5. Reinforcing bars.
7. Anchors, ties, and metal accessories.
8. Concealed lintel system.

I. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

J. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

K. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

B. Concealed Lintel System:
1. Material shall be provided by a manufacturer with at least five years experience in the manufacture of concealed lintel systems.
2. Manufacturer shall demonstrate experience in projects of similar scope.
3. Product must be manufactured in accordance with an established quality assurance program.
4. Product capacity or performance shall be verified by relevant test data or calculation.

C. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

D. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

E. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.
F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of typical wall area as shown on Drawings.

2. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.

3. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.

4. Protect accepted mockups from the elements with weather-resistant membrane.

5. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.

   a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
   
   b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.

6. Protect and maintain mockup as a reference until the conclusion of construction.

G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

H. Coordination Meeting for Stone Anchorage Systems: Prior to submission of shop drawings and other required submittals for the stone veneer, stone anchorage systems, structural steel, miscellaneous steel and cold-formed metal framing, the General Trades Contractor shall hold a coordination meeting with the steel supplier, cold-formed metal framing supplier, stone supplier, stone installer, stone anchorage system engineer retained by the stone supplier and/or installer, cold-formed metal framing engineer, masonry subcontractor, Construction Manager and Architect to review and coordinate the anchorage systems for the interior and exterior stone. The initial meeting shall cover the following:

   1. Responsibilities and extent of work to be provided by each subcontractor, supplier and installer for the stone anchorage systems.
   
   2. Coordination of work to be provided by each subcontractor, supplier and installer for the stone anchorage systems.
   
   3. Review schedule of work to be provided by each subcontractor, supplier and installer for the stone anchorage systems.
   
   4. Impact of work to be provided by each subcontractor, supplier and installer for the stone anchorage systems on work by other contractors, subcontractors, installers and suppliers.
   
   5. Determine date(s) for follow-up meetings, if required, to complete coordination of the work to be provided by each subcontractor, supplier and installer for the stone anchorage systems.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Deliver concealed lintel system to job site in original factory packaging to ensure proper handling in transit.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
E. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

F. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.
   2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
   1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
   2. Protect sills, ledges, and projections from mortar droppings.
   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
   4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.


PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.
B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

A. Regional Materials: Provide CMUs that have been manufactured within 500 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide square-edged units for outside corners unless otherwise indicated.

C. CMUs: ASTM C 90 Normal Weight or Lightweight Aggregate.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2500 psi for wall heights greater than 16'-6” and 2000 psi elsewhere unless noted otherwise.
2. Density Classification: Lightweight or Normal weight unless otherwise indicated.
3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
4. Provide UL Classification D-2 units for fire rated concrete masonry walls.

D. Decorative CMU Veneer: ASTM C 90.

1. Basis of Design Product: Subject to compliance with requirements, provide Decro Face Veneer as manufactured by Masonry Processes, Inc., and distributed by Barnes&Cone, Syracuse, NY 315.437.0305, or approved equal.
2. Thickness: 4” nominal.
3. Size: 16” x 24”.
4. Pattern and Texture:
   a. Match Architect's samples.
5. Colors: Match Architect's samples.
7. It is the Architect's intent to have the color of this masonry match the limestone veneer on this project. This color selection will be confirmed during the submittal process to assure that it matches the limestone supplied for the project. [C]

2.3 CONCRETE AND MASONRY LINTELS

A. General: Provide one of the following:

B. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Division 03 Section "Cast-in-Place Concrete," and with reinforcing bars indicated.

C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.
2.4 CONCEALED LINTEL SYSTEM FOR BRICK VENEER

A. Basis of Design: Subject to requirements, provide 'Concealed Lintel System' and accessories as manufactured by HALFEN Anchoring Systems, Converse, TX, or approved equal.
   1. Concealed lintel system shall be comprised of fabricated spines and accessories.
   2. Lintel system components shall be fabricated from stainless steel to ASTM A666 type 304, annealed.

2.5 BRICK

A. Regional Materials: Provide brick that has been manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:

   1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
   2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
   3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
   4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
   5. Provide special shapes as shown on Drawings.
   6. Provide cored bricks for internally reinforced lintels as detailed in Drawings.

C. Face Brick: Facing brick complying with ASTM C 216.

   1. Products: Subject to compliance with requirements, provide the following:
      a. Brandywine Handmade as manufactured by Glen-Gery Corporation (no substitutions permitted).
   2. Grade: SW.
   3. Type: FBA.
   4. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 4000 psi.
   5. Initial Rate of Absorption: May exceed 30 g/30 sq. in. per minute when tested per ASTM C 67.
      a. Bricks should be field tested to determine wetting requirements.
      b. Typically, Glen-Gery handmade brick should be wetted prior to laying.
   7. Application: Use where brick is exposed unless otherwise indicated.
   8. Where shown to "match existing," provide face brick matching color range, texture, and size of existing adjacent brickwork.

D. Salvaged Face Brick: To be cleaned and reinstalled as indicated on Drawings.

2.6 MORTAR AND GROUT MATERIALS

A. Regional Materials: Provide aggregate for mortar and grout, cement, and lime that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
B. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

C. Hydrated Lime: ASTM C 207, Type S.

D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Davis Colors; True Tone Mortar Colors.
   b. Lanxess Corporation; Bayferrox Iron Oxide Pigments.
   c. Solomon Colors, Inc.; SGS Mortar Colors.

2. Match mortar color of adjacent Henderson North building.
   a. Due to variations in the coloration of the brick and mortar on the existing Henderson North Building, the Owner and Architect will designate an area of the existing masonry to use in matching the mortar color.

F. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
3. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
4. Match mortar color of adjacent Henderson North building.
   a. Due to variations in the coloration of the brick and mortar on the existing Henderson North Building, the Owner and Architect will designate an area of the existing masonry to use in matching the mortar color.


H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Euclid Chemical Company (The); Accelguard 80.
   c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.

I. Water: Potable.
2.7 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Reinforcing that requires welding or field bending shall be ASTM A706 fy=60 ksi.

C. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: Hot-dip galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized, carbon steel.
5. Wire Size for Veneer Ties: 0.148-inch diameter.
6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
7. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
8. Provide reinforcement @ min. 16” vertically, unless noted otherwise.

D. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

E. Masonry Joint Reinforcement for Multiwythe Masonry:
   1. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches. Size ties to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.

F. Masonry Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.187-inch- diameter, hot-dip galvanized, carbon-steel continuous wire.

2.8 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

2. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.

C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- diameter, hot-dip galvanized steel wire.
2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.187-inch- diameter, hot-dip galvanized steel wire.

D. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.05-inch- thick, steel sheet, galvanized after fabrication in areas
where humidity does not exceed 75%; 0.109-inch- thick, stainless-steel sheet in areas where humidity exceeds 75%.

2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.187-inch- diameter, hot-dip galvanized steel wire.

E. Partition Top anchors: 0.105-inch- thick metal plate with 3/8-inch- diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

F. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.

1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.

G. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:

   a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.

2. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) Dayton Superior Corporation, Dur-O-Wal Division; D/A 210 with D/A 700-708.
      2) Heckmann Building Products Inc.; 315-D with 316.
      3) Hohmann & Barnard, Inc.; DW-10 or DW-10HS.
      4) Wire-Bond; 1004, Type III.

   b. Anchor Section: Sheet metal plate, 1-1/4 inches wide by 6 inches 9 inches long, with screw holes top and bottom and with raised rib-stiffened strap, 5/8 inch wide by 3-5/8 inches 5-1/2 inches long, stamped into center to provide a slot between strap and plate for inserting wire tie.

   c. Fabricate sheet metal anchor sections and other sheet metal parts from 0.109-inch-thick, stainless-steel sheet.

   d. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.187-inch-diameter, hot-dip galvanized steel wire.

2.9 MISCELLANEOUS ANCHORS

A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.

B. Dovetail Slots in Concrete: Furnish dovetail slots with filler strips, of slot size indicated, fabricated from 0.034-inch, galvanized steel sheet.

C. Anchor Bolts: Headed steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

D. Postinstalled Anchors: Torque-controlled expansion anchors or chemical anchors.
1. Load Capacity: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

2. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5 unless otherwise indicated.


2.10 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and Division 07 Section "Sheet Metal Flashing and Trim" and as follows:

1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch thick.
2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
3. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at 3-inch intervals along length of flashing to provide an integral mortar bond.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) Cheney Flashing Company; Cheney Flashing (Dovetail) or Cheney 3-Way Flashing (Sawtooth).
4. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
5. Fabricate metal drip edges for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least 3 inches into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam will shed water.
6. Metal Drip Edge: Fabricate from stainless steel. Extend at least 3 inches into wall, and terminate at face of wall as indicated on the Drawings.
7. Metal Sealant Stop: Fabricate from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
8. Metal Expansion-Joint Strips: Fabricate from stainless steel to shapes indicated.

B. Application: Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counterflashing, use metal flashing.
2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing.
4. Where flashing is fully concealed, use metal flashing.

C. Solder and Sealants for Sheet Metal Flashings:

1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
2. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight. Comply with recommendations by sheet metal manufacturer and
fabricator of components being sealed and comply with requirements for joint sealants as specified in Division 7 Section “Joint Sealants.”

D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer’s standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

E. For any other flashings or sheet metal work associated with Unit Masonry, see Division 07 Section “Sheet Metal Flashing and Trim.”

2.11 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep/Vent Products: Use the following unless otherwise indicated:

1. Wicking Material: Absorbent rope, made from cotton, 1/4 to 3/8 inch in diameter, in length required to produce 2-inch exposure on exterior and 18 inches in cavity. Use only for weeps.


E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Advanced Building Products Inc.; Mortar Break II.
   b. Archovations, Inc.; CavClear Masonry Mat.
   c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
   d. Mortar Net USA, Ltd.; Mortar Net.

2. Provide one of the following configurations:

   a. Strips, not less than 1-1/2 inches thick and 10 inches high, with dimpled surface designed to catch mortar droppings and prevent weep holes from clogging with mortar.

F. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
   c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
   d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.
2.12 CAVITY-WALL INSULATION

A. Extruded-Polystyrene Board Insulation with Increased R-Value:  ASTM C 578, Type IV, but with an aged thermal resistance (R-value) for 1-inch thickness of 5.6 deg F x h x sq. ft./Btu at 75 deg F at 5 years; closed-cell product with a carbon-black filler and extruded with an integral skin.

B. Adhesive:  Type recommended by insulation board manufacturer for application indicated.

2.13 MASONRY CLEANERS

A. Proprietary Acidic Cleaner:  Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.14 MORTAR AND GROUT MIXES

A. General:  Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime mortar unless otherwise indicated.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix:  Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry:  Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type S.
2. For reinforced masonry, use Type S.
3. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
4. For interior non-load-bearing partitions, Type O may be used instead of Type N.

D. Mortar Color Matching:  Mortar color and texture shall match adjacent Henderson North building. Color match should be achieved, first, through the use of colored aggregate, and second, through the use of pigmented mortar. Provide samples of a range of custom mixes to Architect and Owner for approval.

a. Due to variations in the coloration of the brick and mortar on the existing Henderson North Building, the Owner and Architect will designate an area of the existing masonry to use in matching the mortar color.

b. Review of the mortar color match will be part of the overall review of the mock-up panel required by this section. Final approval of mortar will not be issued until the mortar color on the mock-up panel is accepted by the Owner and Architect.

E. Pigmented Mortar:  Produce required mortar color by using natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes.
1. Mix to match brickwork on adjacent Henderson North building.
   a. Due to variations in the coloration of the brick and mortar on the existing Henderson North Building, the Owner and Architect will designate an area of the existing masonry to use in matching the mortar color.

2. Application: Use pigmented mortar for exposed mortar joints with the following units:
   a. Face brick.

F. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
   a. Mix to match mortar in brickwork on adjacent Henderson North building.
   b. Due to variations in the coloration of the brick and mortar on the existing Henderson North Building, the Owner and Architect will designate an area of the existing masonry to use in matching the mortar color.

G. Grout for Unit Masonry: Comply with ASTM C 476.
   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
   2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
   2. Verify that foundations are within tolerances specified.
   3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
   1. Mix units from several pallets or cubes as they are placed.

F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.
   1. Due to variations in the coloration of the brick and mortar on the existing Henderson North Building, the Owner and Architect will designate an area of the existing masonry to use in matching the mortar color.

G. Install salvaged existing face brick as shown on Drawings.

H. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:
   1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
   2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
   3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:
   1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
   2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
   3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
   4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
   5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
   6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
   7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:
   1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
   2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
   3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.

5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in Flemish bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches above bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

   1. Install compressible filler in joint between top of partition and underside of structure above.
   2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.
   3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 07 Section "Fire-Resistive Joint Systems."

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

   1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
   2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
   3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
   4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 CAVITY WALLS

A. Bond wythes of cavity walls together as follows:
      a. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

C. Strike joints of CMU backup wall flush and allow wall to cure before coating cavity face of backup wythe to comply with Division 07 Section “Fluid-Applied Membrane Air Barriers.”

D. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
   1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.7 MASONRY-CELL INSULATION

A. Pour granular insulation into cavities to fill void spaces. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of insulation to 1 story high, but not more than 20 feet.

B. Install molded-polystyrene insulation units into masonry unit cells before laying units.

3.8 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
   1. Space reinforcement not more than 16 inches o.c.
   2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
   3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.9 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 1/2 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 16 inches o.c. vertically and 24 inches o.c. horizontally.

3.10 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers to concrete and masonry backup with masonry-veneer anchors to comply with the following requirements:

1. Fasten anchors to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
2. Embed tie sections in masonry joints. Provide not less than 2 inches of air space between back of masonry veneer and face of sheathing.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as indicated, but not more than 16 inches o.c. vertically and 24 inches o.c. horizontally, with not less than 1 anchor for each 2 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 8 inches, around perimeter.

3.11 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry as follows:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.

C. Form expansion joints in brick as follows:

1. Build in compressible joint fillers where indicated.
2. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Division 07 Section "Joint Sealants."
D. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants," but not less than 3/8 inch.

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.12 LINTELS

A. Install steel lintels where indicated.

B. Where indicated, cut lip in brick to be ¾" x ¾" – see details on Drawings. Lip should be proper size for installation of lintel, mortar bed and flashing while maintaining a normal size soft joint to receive sealant below the steel lintel.

C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.13 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. Install flashing according to the requirements of Division 07 Section "Sheet Metal Flashing and Trim," and as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.

2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 4 inches, and 1-1/2 inches into the inner wythe. Form 1/4-inch hook in edge of flashing embedded in inner wythe.

3. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under building paper or building wrap, lapping at least 4 inches.

4. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.

5. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.

6. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.

C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use specified weep/vent products to form weep holes.
2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
3. Space weep holes formed from wicking material 16 inches o.c.
4. Trim wicking material flush with outside face of wall after mortar has set.
E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

F. Install vents in head joints in exterior wythes as indicated, spaced @ 16” o.c. Use specified weep/vent products to form vents.

3.14 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

3.15 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Level 1 special inspections according to the "International Building Code."

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

E. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.

F. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

G. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.
H. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.

I. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

J. Prism Test: For each type of construction provided, according to ASTM C 1314 at 7 days and at 28 days.

3.16 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
   3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
   4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
   6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.
   7. Clean stone trim to comply with stone supplier's written instructions.
   8. Clean limestone units to comply with recommendations in ILI's "Indiana Limestone Handbook."

3.17 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
   1. Crush masonry waste to less than 4 inches in each dimension.
   2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 31 Section "Earth Moving."
   3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.
SECTION 04 43 00 - STONE MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following applications of stone masonry:
   1. Anchored to concrete backup.
   2. Anchored to unit masonry backup.
   3. Anchored to structural steel and metal fabrications.
   4. Anchored to cold-formed metal framing and sheathing in interior applications.
   5. Types and locations of stone include:
      a. Exterior limestone veneer
      b. Interior limestone veneer
      c. Interior granite veneer
      d. Interior sandstone veneer
   6. Through-wall flashing for stone masonry is included in this section, but shall also comply with the requirements of Division 7 section “Flashing and Sheet Metal.”
   7. All miscellaneous metal fabrications required for support of stone masonry is work of this section, but shall also comply with the requirements of division 5 Section “Metal Fabrications.”

B. Related Sections:
   1. Division 03 Section "Cast-in-Place Concrete" for dovetail slots in concrete for anchoring stone.
   2. Division 04 Section "Unit Masonry" for cavity-wall insulation, concealed flashing, horizontal joint reinforcement and veneer anchors.
   3. Division 04 Section “Stone Veneer Site Walls” for stone types and finishes to match those in this section.
   4. Division 07 Section "Thermal Insulation" for cavity-wall insulation installed between stone masonry and backup material.
   5. Division 07 Section "Sheet Metal Flashing and Trim" for exposed sheet metal flashing other than the flashing specified in this section.
   6. Division 09 Section “Stone Flooring” for stone types and finishes to match those in this section.

C. Products installed, but not furnished, in this Section include:
   1. Steel lintels and shelf angles for stone masonry specified in Division 05 Section "Metal Fabrications."

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide stone masonry cladding capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

B. All anchorage components, miscellaneous metal fabrications and cold formed framing systems indicated on the drawings for support of stone are diagrammatic and are not intended to be
complete or to restrict the Prime Contractor to specific anchorage or support systems. The Stone masonry Contractor shall be solely responsible for the structural performance of all stone work, including but not limited to the following, at no additional cost to the Owner:

1. Stone anchorage systems types for gravity anchors, wind/lateral anchors, and other conditions as indicated or required.
2. The systems utilized for attachment of exterior stone gravity and wind/lateral anchors to existing back-up wall as required to prevent movement or slipping of anchors. The method of attachment and types of anchors, metal fabrications and other materials and accessories shall be designed and selected by the Prime Contractor based on both the specified performance requirements and the limitations of the strength of the existing backup wall materials and wall systems design.
3. Coordination of anchor systems with existing back up structure as required.

C. Thermal Movements: Provide stone masonry cladding system that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing displacement of stone, opening of joints, overstressing of components, failure of joint sealants and connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

D. Design stone supports and anchors, including cold formed steel backup framing systems, miscellaneous metal support fabrications and connections to building structure, to withstand loads indicated without exceeding allowable stresses established by the following:

2. For Cold-Formed Steel: AISI SG-673, Part I, "Specification for the Design of Cold-Formed Steel Structural Members."
3. For Cold-Formed Stainless Steel: ASCE 8, "Specification for the Design of Cold-Formed Stainless Steel Structural Members."
4. For Cast-in-Place and Post-Installed Anchors in Concrete: One-fourth of anchor's tested capacity when installed in concrete with compressive strength indicated.
5. For Post-Installed Anchors in Grouted Concrete Masonry Units: One-sixth of anchor's tested capacity when installed in concrete masonry units indicated.

E. Limit deflection in each cold formed steel backup framing system assembly caused by indicated loads and thermal movements, acting singly or in combination with one another, to the deflection that the stone can withstand, but not more than the following maximums:

1. 1/16 inch, measured in plane of wall.
2. 1/720 of panel's clear span but not more than 1/4 inch, measured perpendicular to wall.

F. Provisions for Fabrication and Erection Tolerances: Allow for fabrication and erection tolerances and for structural deflections from loads and other causes.

1. Coordinate with existing backup wall conditions.
2. Structural-steel fabrication and erection tolerances are specified in Division 5 Section "Structural Steel."
3. Allow for vertical deflection of L/600 or 3/8" in 20-foot span of structural members supporting stone masonry cladding system due to loads (including live loads) imposed on building’s structural frame after stone installation.

G. Control of Corrosion and Staining: Prevent galvanic and other forms of corrosion as well as staining by isolating metals, air/water barrier, sealants, backer rods and other materials from direct contact with incompatible materials. Use materials that are nonstaining to exposed surfaces of stone and joint materials.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
1. For stone varieties proposed for use on Project, include test data indicating compliance with physical properties required by referenced ASTM standards.

B. Shop Drawings: Show details of fabrication and installation of stone masonry cladding, including dimensions and profiles of stone units; arrangement and details of jointing, supporting, anchoring, and bonding stone masonry cladding; and details showing relationship with, attachment to, and reception of adjacent construction and all related work.
   1. Include large scale elevations of all existing façade stone and proposed façade stone, indicating actual joint locations and sizes.
   2. Include large-scale details of decorative surfaces and inscriptions.
   3. Include complete information and details for miscellaneous metal support fabrications including attachment to supporting materials.
   4. Include complete shop drawings and installation details for air/water barrier.
   5. Include complete shop drawings and installation details for flashing and break-formed flashing profiles.

C. Samples for Initial Selection: For colored mortar and other items involving color selection.

D. Samples for Verification:
   1. For each stone type indicated. Include at least five samples in each set for each type of stone, exhibiting extremes of the full range of color and other visual characteristics expected in completed Work. Samples will establish the standard by which stone provided will be judged.
   2. Provide two cut corner limestone units, full thickness of veneer stone to be used in project and 8” in height.
   3. Contractor’s Option: Provide two sample preassembled mitered corner units of limestone bonded together with adhesive and stainless steel corner pins. Samples to be full thickness of veneer stone used in project, 8”in height.
   4. For each color of mortar required. Label Samples to indicate types and amounts of pigments used.
   5. Samples of each type of anchor and accessory specified.
   6. Samples of each break-formed flashing profile required.

E. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, sources of supply, and other information as required to identify materials used. Include mix proportions for mortar and source of aggregates.
   1. Submittal is for information only. Neither receipt of list nor approval of mockups constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

F. Qualification Data: For qualified Installer.

G. Engineering Analysis: Submit engineering analysis signed and sealed by a qualified professional engineer for stone masonry cladding, miscellaneous metal fabrications, cold formed steel framing backup systems and stone anchorage system including drawings and comprehensive engineering analysis that shows the system’s compliance with specified requirements.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed stone masonry cladding similar in material, design, and extent to that indicated for Project that has resulted in construction with a record of successful in-service performance.
   1. Installer shall assume responsibility for engineering, fabricating, and installing stone masonry cladding system.
   2. Engineering Responsibility: Engage a qualified professional engineer to prepare or supervise the preparation of data for stone masonry cladding, miscellaneous metal fabrications, cold formed steel framing backup systems and stone anchorage system including drawings and
comprehensive engineering analysis that shows the system’s compliance with specified requirements.

3. Engineer shall be licensed in the commonwealth of Pennsylvania, and shall provide proof and references from the design of three (3) previous stone support systems

B. Source Limitations for Stone: Obtain stone, regardless of finish, from one quarry with resources to provide materials of consistent quality in appearance and physical properties.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

D. Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockup of typical wall area as shown on Drawings.
      a. First mockup consists of stonework integrated into freestanding wall section combined with other materials such as Unit Masonry, Curtain Wall, etc.
      b. Second mockup consists of in-place installation of stone pieces and accessories indicated in the Drawings.
   2. Protect accepted mockups from the elements with weather-resistant membrane.
   3. Approval of mockups is for color, texture, and blending of stone; relationship of mortar and sealant colors to stone colors; tooling of joints; and aesthetic qualities of workmanship.
      a. Approval of mockups is also for other material and construction qualities Architect specifically approves in writing.
      b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Protect and maintain mockup as a reference until the conclusion of construction.
   5. Second in-place mockup may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

C. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

D. Store stone masonry and masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.
   1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.
   2. Store stone on wood skids or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation.
1.7 PROJECT CONDITIONS

A. Protection of Stone Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed stone masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.

B. Stain Prevention: Immediately remove mortar and soil to prevent them from staining the face of stone masonry.
   1. Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on the ground and over the wall surface.
   2. Protect sills, ledges, and projections from mortar droppings.
   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
   4. Turn scaffold boards near the wall on edge at end of each day to prevent rain from splashing mortar and dirt on completed stone masonry.

C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace stone masonry damaged by frost or freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
   1. Cold-Weather Construction: When ambient temperature is within limits indicated, use the following procedures:
      a. At 40 deg F and below, produce mortar temperatures between 40 and 120 deg F by heating mixing water and, at temperatures of 32 deg F and below, sand. In heating mortar materials, maintain mixing temperatures selected within 10 deg F; do not heat water for mortar to above 160 deg F. Maintain temperature of mortar on boards above freezing.
      b. At 25 to 20 deg F, heat both sides of walls under construction. Use windbreaks or enclosures when wind velocity exceeds 15 mi./h.
      c. At 20 deg F and below, provide enclosure and auxiliary heat to maintain air temperature above 32 deg F within enclosure. Heat stone so it is above 40 deg F at time of installation.
   2. Cold-Weather Protection: When mean daily temperature is within limits indicated, provide the following protection:
      a. 40 to 25 deg F: Cover stone masonry cladding with a weather-resistant membrane for 48 hours after construction.
      b. 25 to 20 deg F: Cover stone masonry cladding with insulating blankets or provide enclosure and heat to maintain air temperature above 32 deg F within enclosure for 48 hours after construction. Use windbreaks or enclosures when wind velocity exceeds 15 mi./h.
      c. 20 deg F and Below: Provide enclosure and heat to maintain air temperature above 32 deg F within enclosure for 48 hours after construction.
   3. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.


1.8 COORDINATION

A. Advise installers of other work about specific requirements for placement of reinforcement, veneer anchors, flashing, and similar items to be built into stone masonry.
PART 2 - PRODUCTS

2.1 LIMESTONE

A. Limestone: Comply with ASTM C 568.
   1. Products: Indiana oolitic limestone quarried in Lawrence, Monroe, or Owen Counties, Indiana.
   2. Classification: II Medium-Density.

B. Indiana Oolitic Limestone Grade, Color, and Finish: Select Grade; Buff Color; Smooth, machine finish, complying with indicated grade, color classification and finish standard established by Indiana Limestone Institute of America (ILI).
   1. Match existing limestone on Henderson North Building for color, uniformity of color, finish, and other stone characteristics relating to aesthetic effects.

C. Natural defects in the stone with visual variations beyond those present in the existing building will not be acceptable.

2.2 GRANITE

A. Granite: Comply with ASTM C 615.
   1. Products: Subject to compliance with requirements, provide Virginia Mist, Jet Mist or equivalent as manufactured by North Carolina Granite, Inc. and distributed by Architectural Craft Stone Source, Inc., Flushing, NY 11367, or equal. Tel: 718.820.8885.
      a. Granite Veneer, Finish 1 – Honed, as defined by Architectural Craft Stone Source.
      b. Granite Veneer, Finish 2 – Smooth, as defined by Architectural Craft Stone Source.
      d. Thickness as shown in the Drawings.

B. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.3 SANDSTONE

A. Sandstone shall be Briar Hill Sandstone (Massillon formation), dimensions indicated on the Drawings, manufactured by Briar Hill Stone Co., Glenmont, OH 44628, or approved equal. Contact (216) 377-5100.
   1. Majority of sandstone work to be Sandstone Veneer, Finish 1 – Rough.
   2. Where indicated on Drawings, provide Sandstone Veneer, Finish 2 – Smooth.

B. Sandstone shall be a range of light, medium, and dark buff colors with rock face finish.

2.4 MORTAR MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
   1. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or III, and hydrated lime complying with ASTM C 207.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Essroc, Italcementi Group; Capitol PCL Blend or Saylor's Plus.
D. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in stone masonry mortar.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Davis Colors; True Tone Mortar Colors.
      b. Lanxess Corporation; Bayferrox Iron Oxide Pigments.
      c. Solomon Colors; SGS Mortar Colors.

E. Aggregate: ASTM C 144 and as follows:
   1. For pointing mortar, use aggregate graded with 100 percent passing No. 16 sieve.
   2. Colored Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.
      a. Match mortar used in limestone work at Henderson North building.

F. Water: Potable.

2.5 ANCHORS

A. Provide anchors of type and size required to support stone masonry cladding and to sustain imposed loads. Select stone anchors and anchor fasteners which are suitable for existing back up wall substrate. Coordinate anchor design with existing in-place adjacent stone masonry. Fabricate from the following metals for conditions indicated:
   1. Stainless Steel: ASTM A 666, Type 304, temper as required to support loads imposed without exceeding allowable design stresses.
      a. Fasteners for Stainless-Steel Anchors: Annealed stainless-steel bolts, nuts, and washers of same alloy as anchors. ASTM F 593 for bolts and ASTM F 594 for nuts.

B. Post-Installed Anchors in Backup Construction: Anchors of type indicated below, fabricated from corrosion-resistant materials, with capability to sustain, without failure, load imposed within factors of safety indicated for connections, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency. Coordinate anchor type with backup wall construction.
   2. Chemical anchors.
   3. Expansion anchors.
   4. Undercut anchors.

2.6 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with Division 07 Section "Sheet Metal Flashing and Trim."

B. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual and Division 07 Section "Sheet Metal Flashing and Trim" and as follows:
   1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch thick.
   2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet.
   3. Do not expose cut edges of sheet metal except as shown. Fold back exposed ends of unsupported sheet metal to form a 1/2" wide hem on the concealed side, or ease exposed edges with backing to a radius of approximately 1/32". Form items with flat, flush surfaces, true to line and level, and without cracking and grain separation at bends.
4. Continuously weld all joints and seams except where other methods of joining are indicated; grind welds smooth and flush on exposed surfaces. Comply with AWS and other metal authorities.
   a. Use filler metals and welding procedures which will blend with and match the color of sheet metal being joined and will avoid discoloration at welds.

5. Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, noncorrosive metal recommended by sheet metal manufacturer.
   a. Size: As recommended by SMACNA manual or sheet metal manufacturer for application but never less than thickness of metal being secured.

6. Fabricate through-wall flashing with drip edge as detailed in the Drawings unless otherwise indicated.

7. See Division 07 Section “Sheet Metal Flashing and Trim” for all other flashings not described here.

C. Solder and Sealants for Sheet Metal Flashings:
   1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
   2. Solder for Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.

2.7 LEAD T-CAP WEATHERSTRIPPING

A. Lead T-Cap: Soft lead strip to be set and bedded in joint sealant to form a cap and assure a permanent elastic seal for masonry joint.
   1. Provide Lead T-Cap by Nuclead, or equal.
   2. Size per manufacturer’s instructions based upon width of masonry joint.
   3. Installation locations:
      a. Top, side and cross joints of copings. Extend from outer face, across the top of the coping and down parapet side.
      b. All cross joints on cornices and belt courses that are not flashed. Carry down front face of stone to first change in contour.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from closed cell neoprene.

B. Weep/Vent Products: Use the following unless otherwise indicated:
   1. Wicking Material: Absorbent rope, made from cotton, 1/4 to 3/8 inch in diameter, in length required to produce 2-inch exposure on exterior and 18 inches in cavity. Use only for weeps.

C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
   1. Provide one of the following configurations:
      a. Strips, not less than 1-1/2 inches thick and 10 inches wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
      2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
         a. Advanced Building Products Inc.; Mortar Break II.
         b. CavClear/Archovations, Inc.; CavClear Masonry Mat.
         c. Dur-O-Wal, a Dayton Superior Company; Polytite MortarStop.
         d. Mortar Net USA, Ltd.; Mortar Net.
D. Setting Buttons: Lead or resilient plastic buttons, nonstaining to stone, sized to suit joint thicknesses and bed depths of stone masonry cladding involved without intruding into required depths of joint sealants or causing third-side adhesion between sealant and setting button.

E. Epoxy: Two-component epoxy adhesive for joining preassembled L-shaped limestone pieces to be used at building corners, soffits and fascia.

F. Type 304 or 316 stainless steel pins for joining preassembled L-shaped limestone pieces to be used at building corners, soffits and fascia.

G. Dampproofing for Back of Limestone Panels: Apply bituminous material to limestone at grade as indicated on the Drawings.

2.9 CAVITY-WALL INSULATION

A. See Division 04 Section “Unit Masonry” for cavity-wall insulation to be used in both Unit Masonry and Stone Masonry wall construction.

2.10 MASONRY CLEANERS & SEALERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar and grout stains, efflorescence, and other new construction stains from stone masonry surfaces without discoloring or damaging masonry surfaces; expressly approved for intended use by cleaner manufacturer and stone producer.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Diedrich Technologies, Inc.
   b. Dominion Restoration Products.
   c. EaCo Chem, Inc.
   d. Hydrochemical Techniques, Inc.
   e. Prosoco, Inc.

B. Limestone & Sandstone Sealer: Provide stone supplier’s recommended sealer product for limestone and sandstone veneers. Sealer to be matte finish, non-staining, non-color changing.

2.11 MORTAR MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride.
2. Limit cementitious materials in mortar to portland cement and lime.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
4. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.


1. Mortar for Setting Stone: Type N.
2. Mortar for Pointing Stone: Type N.

C. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Mix to match Architect's sample.

D. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
   1. Mix to match Architect's sample.

2.12 FABRICATION

A. Fabricate stone to comply with sizes, shapes, and tolerances recommended by applicable stone association or, if none, by stone source, for faces, edges, beds, and backs.
   1. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
   2. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."

B. Cut stone to produce pieces of thickness, size, and shape indicated, including details on Drawings. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated.

C. Cut stone to produce joints of uniform width and in locations indicated.
   1. Typical Joint Width: 1/8 inch except as otherwise indicated.

D. Cut and drill sinkages and holes in stone for anchors and supports.

E. Carefully inspect stone at quarry or fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.
   1. Clean sawed backs of stone to remove rust stains and iron particles.

F. Gage backs of stones for adhered veneer if more than 81 sq. in. in area.

G. Thickness of Stone: Provide thickness indicated, but not less than the following:
   1. Thickness: 4 inches plus or minus 1/4 inch. Thickness does not include projection of pitched faces.

H. Shape stone for type of masonry (pattern) as follows:
   1. Sawed-bed, range ashlar with uniform course heights and uniform lengths as indicated on Drawings.

I. Contractor’s Option: In lieu of cut L-shaped corner stones, provide preassembled mitered stone corner pieces. Mitered corner stones to be joined using two-part epoxy and stainless steel pins in accordance with recommendations listed in the Indiana Limestone Handbook (article 2.5), latest edition.

J. Finish exposed faces and edges of stone to comply with requirements indicated for finish and to match approved samples and mockups.
   1. Finish: Smooth.
   2. Finish for Sills: Smooth.
      a. Finish exposed ends of copings same as front and back faces.

K. Fabricate molded work, including washes and drips, to produce stone shapes with a uniform profile throughout entire unit length and with precisely formed arris slightly eased to prevent snipping, and matched at joints between units.
   1. Produce moldings with machines having abrasive shaping wheels made to reverse contour of molding shape; do not sculpt moldings.

L. Carefully inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.
1. Grade and mark stone for overall uniform appearance when assembled in place. Natural variations in appearance are acceptable if installed stone units match range of colors and other appearance characteristics represented in approved samples and mockups.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive stone masonry, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine substrate to verify that dovetail slots, inserts, reinforcement, veneer anchors, flashing, and other items installed in substrates and required for or extending into stone masonry are correctly installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the installation shall constitute acceptance of the surfaces to receive stone masonry and conditions under which stone masonry shall be installed.

3.2 PREPARATION

A. Coat concrete and unit masonry backup with asphalt dampproofing.

B. Protect stone masonry work during erection as follows:
   1. Cover tops of walls with nonstaining, waterproof sheeting at end of each day's work. Cover partially completed structures when work is not in progress. Extend cover a minimum of 24 inches down both sides and hold securely in place.
   2. Prevent staining of stone from mortar, grout, sealants, and other sources. Immediately remove such materials without damaging stone.
   3. Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on ground and over wall surface.
   4. Protect sills, ledges, and projections from mortar and sealant droppings.

C. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 SETTING OF STONE MASONRY, GENERAL

A. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance.

B. Set stone to comply with requirements indicated on Drawings. Install supports, fasteners, and other attachments indicated or necessary to secure stone masonry in place. Set stone accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.

C. Provide sealant joints of widths and at locations indicated.
   1. Keep sealant joints free of mortar and other rigid materials.
   2. Sealing joints is specified in Division 07 Section "Joint Sealants."

D. Install embedded flashing and weep holes at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
1. At multiwythe masonry walls, including cavity walls, extend flashing through stone masonry, turned up a minimum of 8 inches, and extend into or through inner wythe to comply with requirements in Division 04 Section "Unit Masonry."

2. At lintels and shelf angles, extend flashing full length of angles but not less than 6 inches into masonry at each end.

3. At sills, extend flashing not less than 4 inches at ends.

4. At ends of head and sill flashing turn up not less than 2 inches at ends.

5. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Division 07 Section “Joint Sealants” for application indicated.

6. Install metal drip edges with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.

E. Coat limestone with bituminous dampproofing in accordance with the Limestone Institute Manual and as shown on the Drawings, and as follows:

1. Stone Extending below Grade:
   a. First Application: Apply bituminous dampproofing to beds, joints, back surfaces, and face surfaces up to rough grade.
   b. Final Application: Complete application of dampproofing on front face of exposed stone pieces in place after fine grading line has been determined.

2. Allow dampproofing formulations to cure before setting dampproofed stone or final grading. Do not damage or remove dampproofing in the course of handling and setting stone.

F. Keep cavities open where unfilled space is indicated between back of stone masonry cladding and back-up wall.

1. Institute and maintain effective procedures to keep cavities clean. Do not fill cavities with mortar, grout or other materials, including materials resulting from installation of anchors in masonry construction.

2. Place weep holes in joints where moisture may accumulate, including base of cavity walls, above shelf angles, and flashing. Locate weep holes at every vertical joint and where indicated in approved shop drawings.

3. Place vent holes in joints where recommended by referenced standards, including top of cavity walls and below shelf angles and flashing. Locate weep holes at every vertical joint and where indicated in approved shop drawings.

4. Place cavity drainage material immediately above flashing in cavities, as stone masonry construction progresses, to splatter mortar droppings and to maintain drainage.

5. Cut weep and vent holes flush with surface of sealant after installation of sealant.

G. Place weep holes and vents in joints where moisture may accumulate, including at base of cavity walls, above shelf angles, and at flashing.

1. Use wicking material to form weep holes above flashing in stone sills. Turn wicking down at lip of sill to be as inconspicuous as possible.

2. Space weep holes formed from wicking material 16 inches o.c.

3. Trim wicking material used in weep holes flush with outside face of wall after mortar has set.

4. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

H. Install vents in vertical head joints at the top of each continuous cavity at spacing indicated. Use round plastic tubing to form vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.
3.4 CONSTRUCTION TOLERANCES

A. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch in 40 feet or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet or 1/2 inch in 40 feet or more.

B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet or 1/2 inch in 40 feet or more.

C. Variation of Linear Building Line: For position shown in plan, do not exceed 1/2 inch in 20 feet or 3/4 inch in 40 feet or more.

D. Measure variation from level, plumb, and position shown in plan as variation of the average plane of the face of each stone from level, plumb, or dimensioned plane.

E. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.

F. Variation in Plane between Adjacent Stones: Do not exceed one-half of tolerance specified for thickness of stone.

3.5 INSTALLATION OF ANCHORED STONE MASONRY

A. Anchor stone masonry to backup with anchors complying with performance criteria defined in this Section. Secure anchors to existing backup wall in compliance with performance criteria.

B. Space anchors as required by performance requirements of this Section.

C. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with mortar.

D. Set stone in full bed of mortar with full head joints unless otherwise indicated. Build anchors into mortar joints as stone is set.

E. Provide minimum 1-inch cavity between stone masonry and backup construction unless otherwise indicated. Keep cavity free of mortar droppings and debris.
   1. Retain first subparagraph below if required by code.
   2. Place mortar spots in cavity at veneer anchors to maintain spacing.
   3. Slope beds toward cavity to minimize mortar protrusions into cavity.
   4. Do not attempt to trowel or remove mortar fins protruding into cavity.

F. Rake out joints for pointing with mortar to depth of not less than 1/2 inch before setting mortar has hardened. Rake joints to uniform depths with square bottoms and clean sides.

3.6 POINTING

A. Prepare stone-joint surfaces for pointing with mortar by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply pointing mortar in layers not more than 3/8 inch deep until a uniform depth is formed.

B. Point stone joints by placing and compacting pointing mortar in layers not more than 3/8 inch deep. Compact each layer thoroughly and allow to become thumbprint hard before applying next layer.

C. Tool joints, when pointing mortar is thumbprint hard, with a smooth jointing tool to produce the following joint profile:
   1. Joint Profile: Smooth, flat face slightly below edges of stone.
   2. Match profile of joints in stone masonry of adjacent Henderson North Building.
3.7 ADJUSTING AND CLEANING

A. Remove and replace stone masonry of the following description:
   1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods
      and results are approved by Architect.
   2. Defective joints.
   3. Stone masonry not matching approved samples and mockups.
   4. Stone masonry not complying with other requirements indicated.

B. Replace in a manner that results in stone masonry matching approved samples and mockups,
   complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears
   before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or
      chisels.
   2. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison
      purposes. Obtain Architect's approval of sample cleaning before cleaning stone masonry.
   3. Clean stone masonry not less than 6 days after completion of pointing and sealing, using
      clean water and stiff-bristle fiber brushes. Do not use wire brushes, acid-type cleaning
      agents, cleaning compounds with caustic or harsh fillers, or other materials or methods that
      could damage stone.
      a. Protect adjacent surfaces from contact with cleaner by covering them with liquid
         strippable masking agent, polyethylene film, or waterproof masking tape, approved in
         writing by the manufacturer of each adjacent material.
   4. Clean limestone masonry to comply with recommendations in ILI's "Indiana Limestone
      Handbook."

3.8 EXCESS MATERIALS AND WASTE

A. Excess Stone: Stack excess stone where directed by Owner for Owner's use.

B. Disposal as Fill Material: Dispose of clean masonry waste, including mortar and excess or soil-
   contaminated sand, by crushing and mixing with fill material as fill is placed.
   1. Crush masonry waste to less than 4 inches in greatest dimension.
   2. Mix masonry waste with at least two parts of specified fill material for each part of masonry
      waste. Fill material is specified in Division 31 Section "Earth Moving."
   3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as
   described above, and other waste, and legally dispose of off Owner's property.

END OF SECTION 04 43 00
SECTION 04 4310 - STONE VENEER SITE WALLS [C]

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following applications:

1. Providing Sandstone Veneer for walls at the Garden Area, and the Lawn Terrace and Stage Power Support Wall.

2. Provide Limestone Veneer that matches the existing North Henderson building’s base and site walls. Limestone supplied for all new walls shall also be required to match limestone supplied for the exterior veneer and trim of the new Biobehavioral Health Building. [C]

B. Related Sections include:
1. Division 2, Section 03301, Cast-in-Place Concrete

1.2 SUBMITTALS

A. Stone Samples: For color, grade, finish, and variety of stone.

B. Colored Mortar Samples: For color range.

C. Qualification Data: For stone mason installer.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An installer who employs experienced stone masons and stone fitters who are skilled in installing stone veneer assemblies similar in material, design, and extent to those indicated for this Project and whose projects have a record of successful in-service performance.

B. Mockups: Build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution.

1. Build mockup of stone veneer assembly in sizes approximately 36 inches long by 18 inches high by full thickness, including face and backup. Approved mock may be used as part of completed wall assembly if approved without changes.

1.4 PROJECT CONDITIONS

A. Protection of Stone Veneer Assemblies: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day’s work.

B. Stain Prevention: Immediately remove mortar and soil to prevent them from staining the face of stone veneer assemblies.
C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried.


PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified.
   2. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 SANDSTONE

A. General: Fabricate stone in sizes and shapes necessary to comply with requirements indicated, including details on Drawings.

B. Sandstone veneer shall be Briar Hill Sandstone (Massillon formation), dimensions indicated on the Drawings, manufactured by Briar Hill Stone Co., Glenmont, OH 44628, or approved equal. Contact (216) 377-5100.

C. Sandstone shall be a range of light, medium, and dark buff colors with rock face finish.

D. Provide stone 6" Ht. x 5" Depth, and in random lengths from 6" to 42".

E. Finish exposed faces and edges of stone to comply with requirements indicated for finish and to match approved samples and mockups.

   1. Finish for veneer facing stone: rock pitch edge, natural cleft top and bottom.
   2. Copingstone shall extend 1" beyond the face of wall.

2.3 LIMESTONE

A. Limestone: Comply with ASTM C 568.

   1. Products: Indiana oolitic limestone quarried in Lawrence, Monroe, or Owen Counties, Indiana.
   2. Classification: II Medium-Density.

B. Indiana Oolitic Limestone Grade, Color, and Finish: Select Grade; Buff Color; Smooth, machine finish, complying with indicated grade, color classification and finish standard established by Indiana Limestone Institute of America (ILI).
1. Match existing limestone on Henderson North Building for color, uniformity of color, finish, and other stone characteristics relating to aesthetic effects.

C. Natural defects in the stone with visual variations beyond those present in the existing building will not be acceptable.

2.4 GENERAL

A. Beds and Joints: Pieces shall be bedded and jointed as shown on the approved shop drawings, and bed joint and vertical joint surfaces shall be cut with 3/16 in. beds and joints, as indicated on the approved shop drawings, sawn or cut full square back from the face at least two-thirds of the piece thickness. From that point the bed may fall under square not more than 1 in.

B. Back of stone which will be concealed in the finished work shall be sawn to approximately true planes. Maximum variation in thickness shall be 3/16 in. Sawn backs shall be cleaned of rust stains and iron particles.

C. All faces shall be at right angles to the plane of the top.

D. Stone shall be accurately cut to required shape and dimensions.

E. Holes, cut-outs, sinkages and openings in stone work for anchors, cramps, dowels, supports, and lifting devices, shall be accurately cut or drilled to required dimensions, as shown on the approved shop drawings, and as necessary to secure granite in place to insure correct location and accurate fit of all fixtures. Setting beds shall be shaped to fit supports.

F. Arrises shall be cut sharp and true to square, and continuous with adjoining arrises. Where exposed, arrises shall be eased.

2.5 SETTING BED MORTAR

A. Setting bed mortar shall conform to ASTM C 270, Type S, except that latex polymer additive shall be mixed with the cementitious materials and aggregate in lieu of water.

1. Cement shall conform to ASTM C 150, complying with the staining requirements of ASTM C91 for not more than 0.03% water-soluble alkali as per ASTM C 114. Furnish Type I, except Type III may be used for cold-weather construction.

2. Sand shall conform to ASTM C 144.

3. Hydrated lime shall conform to ASTM C 207.

4. Latex polymer additive shall be equal to "Laticrete 4237" setting liquid, manufactured by Laticrete International, Inc., Woodbridge, CT 06525. Mix according to manufacturer's instructions.

2.6 MORTAR GROUT FOR POINTING

A. Mortar grout for pointing of joints shall consist of one (1) part white Portland cement, type (2) parts sand, mortar coloring additive, gauged with latex polymer additive.

1. Portland Cement: ASTM C 150, complying with the staining requirements of ASTM C91 for not more than 0.03% water soluble alkali as per ASTM C 114. Furnish Type I, except Type III may be used for cold-weather construction.

2. Color pigment shall not exceed 10% of the Portland cement in the mortar.
3. Latex polymer additive shall be equal to "Laticrete 3701", manufactured by Laticrete International, Inc., Woodbridge, CT 06525. Mix according to manufacturer's instructions.
4. Except as otherwise indicated, all other mortar grout materials shall be as specified in Paragraph 2.04 above.

B. Mortar Grout shall contain a coloring additive. Color shall be approved by the University Representative.
   1. Coloring additive shall be equal to SGS Colors, manufactured by Solomon Grind Chem Service, Springfield, IL 62705.
   2. Mortar coloring additive shall have mineral oxide pigment and shall be certified by the supplier to be resistant to alkali, light, and weather, and shall be of a chemical composition unaffected by cement and free of water and soluble salts.
   3. Color pigment in grout mixture shall not exceed 10% of the Portland cement content.
   4. Color shall match color of stone.

C. Water: Potable.

2.7 VENEER ANCHORS

A. Adjustable Veneer Anchors: 2-piece assemblies that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to wall, for attachment of Veneer Stone to CMU Block and that are capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch. Space anchors at 16” on center vertically.

   1. Screw-Attached Veneer Anchors: Units with triangular wire tie and rib-stiffened, sheet metal anchor section with screw holes top and bottom and with raised rib-stiffened strap stamped into center to provide a slot for connection of wire tie.

      a. Products: Dur-O-Wal, a Dayton Superior Company; D/A 213.

2.8 MASONRY CLEANERS

A. Job-Mixed Detergent Solution: Solution of 1/2-cup dry-measure tetrasodium polyphosphate and 1/2-cup dry-measure laundry detergent dissolved in 1 gal. of water.

2.9 THROUGH WALL FLASHING

A. Provide metal flashing as per Section 04 2113.

   1. Install flashing directly below top of the stone coping, and extend beyond face of wall concealing the flashing under the 1” stone coping overhang. Extend at corners in both directions bending coping down the shed water away for wall.
PART 3 - EXECUTION

3.1 SETTING OF STONE VENEER, GENERAL

A. Perform necessary field cutting, as stone is set, using power saws to cut stone. Trim and cut stone so that edges are dressed.

B. Arrange and trim stones for accurate fit in range horizontal Ashlar pattern with course heights as indicated, random lengths, and uniform joint widths, with offset between vertical joints as indicated.

C. Maintain uniform joint widths except for variations due to different stone sizes and where minor variations are required to maintain bond alignment, if any. Lay walls with joints not less than 3/8 inch at narrowest points, and not more than 5/8 inch at widest points.

3.2 CONSTRUCTION TOLERANCES

A. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch in 40 feet or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet or 1/2 inch in 40 feet or more.

B. Variation from Level: For lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet or 1/2 inch in 40 feet or more.

C. Variation of Curved Wall Line: For position shown in plan, do not exceed 1/2 inch in 20 feet or 3/4 inch in 40 feet or more.

3.3 INSTALLATION OF ANCHORED STONE VENEER ASSEMBLIES

A. Anchor stone veneer to concrete with corrugated-metal veneer anchors as follows:
   1. Embed veneer anchors in mortar joints to within 1 inch of face.

B. Space veneer anchors not more than 16 inches o.c. vertically and 32 inches o.c. horizontally, with not less than 1 veneer anchor per 2.67 sq. ft. of wall area. Install additional veneer anchors within 12 inches of openings, sealant joints, and perimeter at intervals not exceeding 12 inches.

C. Set stone in full bed of mortar with full head joints, unless otherwise indicated. Build veneer anchors into mortar joints, as stone is set.
   1. Install continuous wire reinforcement in horizontal joints indicated and attach to seismic veneer anchors, as stone is set.

D. Fill collar joint with mortar as stone is set.

E. Mortar joints for pointing with mortar to depth of not less than 1 inch. Rake joints uniformly.

F. Install stainless steel setting pins on stone copings as required, see Section 04 4300 for
3.4 ADJUSTING AND CLEANING

A. In-Progress Cleaning: Clean stone veneer assemblies as work progresses. Remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean stone veneer assemblies as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on mockup; leave one-half of panel un-cleaned for comparison purposes.
3. Protect adjacent stone and non-masonry surfaces from contact with cleaner.
4. Wet wall surfaces with water before applying cleaner; remove cleaner promptly by rinsing thoroughly with clear water.
5. Clean stone veneer assemblies by bucket and brush hand-cleaning method described in BIA Technical Note No. 20 Revised II, using job-mixed detergent solution.
6. Clean stone veneer assemblies with proprietary acidic cleaner applied according to manufacturer's written instructions.

3.5 EXCESS MATERIALS AND WASTE

A. Disposal as Fill Material: Dispose of clean masonry waste, including mortar and excess or soil-contaminated sand, from all areas and dispose of off-site.

1. Do not dispose any masonry waste materials on site or within soil or planting beds.

END OF SECTION 04 4310
SECTION 05 12 00 - STRUCTURAL STEEL

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Work of this section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.02 WORK INCLUDED

A. Work of this section includes all labor, materials, equipment and services necessary to complete the structural steel work as shown on the drawings and specified herein, including, but not limited to the following:

1. Furnish and deliver for installation by others, anchor bolts, bearing plates and loose lintels with complete instructions and templates to facilitate installation.
2. Furnish and erect all struts, columns, bearing plates, beams, girders, bracing, hangers, and all related connections (bolted and welded).
3. Openings (unreinforced and reinforced) in structural steel to accommodate mechanical and electrical work.
4. Shop painting and field touch-up painting.
5. Erection bracing and supports, including steel wedges, shims or nuts required for leveling base plates.
6. Brick shelves and angles attached to structural steel as shown on drawings.
7. Unless specifically excluded, furnish and install all other items for structural steel work indicated on the drawings, specified, or obviously needed to make the work of this Section complete.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Installation of anchor bolts furnished under this section.
B. Grout under base and bearing plates.
C. Installation of loose lintels furnished under this section
D. Metal decking.
E. Miscellaneous metal work.
F. Painting and finishing for shop and field painting of structural steel, except as specified herein.
G. Fireproofing systems.

1.04 QUALITY ASSURANCE

A. Codes and Standards: Comply with the applicable provisions and recommendations of the following codes and standards except where more stringent requirements are
shown or specified:

1. Governing Building Codes having jurisdiction over the project. AISC "Specification for Structural Steel Buildings".

2. AISC "Code of Standard Practice for Steel Buildings and Bridges" (paragraph 4.2.1 of the above code is hereby modified by deletion of the following sentence: "This approval constitutes the owner's acceptance of all responsibility for the design adequacy of any connections designed by the fabricator as a part of his preparation of these shop drawings.")


5. AISC "Specifications for Structural Joints Using ASTM A325 or A490 Bolts."

6. ASTM A6 "General requirements for rolled steel plates, shapes, sheet piling and bars for structural use."

7. AWS D1.1, "Structural Welding Code."

8. SSPC "Steel Structures Painting Manual, Volume 2, Systems and Specifications."

B. Qualifications for welding work shall be as follows:

1. Qualify welding procedures and welding operators in accordance with the AWS "Standard Qualification Procedure."

2. Submit certification that all welders to be employed in work are AWS qualified. If re-certification of welders is required, re-testing will be responsibility of structural steel subcontractor.

C. Fabricator Qualifications:

1. Company specializing in structural steel fabrication having a minimum of 5 years successful, documented experience with work comparable to that required for this project.

2. Maintain full-time engineering department.

3. Participant in AISC Quality Certification Program, designated as a Category I Conventional Steel Structures Certified Plant.

1.05 SUBMITTALS

A. Submit shop drawings in accordance with the specifications as follows:

1. Show clearly all work, including relationship of structural steel to the adjacent work of other trades and to significant lines of finishes of other trades. Submit proposed sequencing and erection procedures for review. Submission shall indicate all requirements necessary to accommodate prescribed dead load deflections (camber).

2. Fabrication and erection drawings that are submitted in separate packages for erection sequencing shall be submitted in complete packages. These packages shall include piece, detail and erection sheets for all
elements in that sequence, including but not limited to beams, columns and slab edge elements. All connections between elements shall be detailed. Connection locations for members in other sequences shall be clouded and/or labeled to indicate that it is part of a future sequence. Reviewed members that have connections from elements in other sequences must be resubmitted with new sequences to verify coordination and changes to the previously submitted element. Partial submittals or submittals without the required information will be returned without review.

3. Do not fabricate or deliver work to the site before drawings reviewed by the architect have been returned.

4. Prepare shop drawings in conformance with the best standards of the construction industry, and not less complete than indicated by the applicable procedures shown in "Structural Steel Detailing," Latest Edition, published by AISC. Prepare shop drawings under the supervision of a registered professional engineer, licensed by the state in which the construction is to take place. During the preparation of shop drawings, and prior to submittal, coordinate and cross check all shop drawings, including those prepared by subcontractors, for compliance with the Contract Documents. Each shop drawing shall bear the seal and signature of the engineer in charge of structural steelwork for the steelwork subcontractor, and the initials of the individual actually preparing the drawing.

5. Indicate clearly the size and grade of steel for each component. Identify rolled shapes, tubes and plates by using the standard designations used in "Manual of Steel Construction," Latest Edition, by AISC.

6. Indicate welds and nondestructive tests by using the symbols conforming to AWS A2.4 "Symbols for Welding and Nondestructive Testing." Where necessary for clarity, indicate welding procedure designations or other data in the tail of the welding symbol.

7. Show explicitly the type of connection used in each location, the grade, size, and number of bolts; the type, number, position, designation and orientation of each washer; and the size of each hole, whether slotted or round. Ensure that adequate wrench clearance for correct bolt tightening is provided and note special bolt tightening sequences where applicable and necessary.

8. Show all camber dimensions in the shop drawings. Where specific camber is not shown in the drawings, note on each affected shop drawing that such members are to be fabricated with the natural camber up.

9. Show holes required for securing work specified in other sections to structural steelwork, as well as all holes required for passage through structural steelwork of work by other trades. Provide field work drawings for all such holes not shown in shop or erection drawings. Addition of, or change in size or location of openings will not be permitted without prior approval in writing.

10. Make details in such a way as to avoid having steel, connections, bracing, bolts, etc., interfere with architectural details or in any way reduce the areas of shafts, openings, clearances, etc.

11. Detail and schedule cleaning and painting data and requirements, including specific indication of "no-paint" areas.

12. Prepare original shop drawings. The use of the engineer's or architect's drawings as a base for photographic or other reproduction for shop drawings or details will not be permitted. Show clearly the size and location of each
member and the erection mark assigned to each member. Show each field connection with all data and details necessary for assembling the structure. Direct special attention to the possible need for special guying, bracing, or shoring to prevent deformation of existing or new structure due to stresses caused by erection procedures and equipment, by construction loadings, and by forces of natural phenomena.

13. Prepare, keep up-to-date, and submit a complete drawing index cross-referencing each assigned piece mark with the drawing number in which the piece is detailed. Detail drawings submitted without an up-to-date index and the applicable erection drawing(s) showing the location of each piece will be deemed an incomplete submission and will not be accepted as subject to any agreed shop drawing review schedule.

14. Prepare anchor bolt and base plate erection drawings containing complete location and placing details, including details of all templates. Provide anchor bolt erection drawings to the concrete trade in advance of applicable concrete work and in coordination with concrete construction sequence.

15. Direct the architect’s attention in writing to any proposed deviations from the Contract Documents, prior to the submission of shop drawings showing the proposed deviation. Submit requests for deviations on the steelwork subcontractor’s letterhead. Deviations not identified, or identified only in letters of transmittal or in shop drawings or both, without the required written request, may not be accepted, and shall be sufficient cause for the architect to return each shop drawing containing such deviations without further action. Acceptance of shop drawings containing deviations not detected by the architect during shop drawing review shall not relieve the steelwork subcontractor from responsibility to conform strictly to the Contract Documents.

16. Prior to resubmission of shop drawings with additions or corrections, circle and identify all changes. Drawings submitted without each change being clearly identified are subject to return for resubmission.

17. Prior to making shop drawings for any portion of the work involving alterations to an existing structure, make all necessary field observations, measurements and surveys of existing conditions. If probes are required to accomplish such measurements, give timely notice where probes will be required.

B. Submit certified copies of each survey conducted by a surveyor licensed by the state in which the construction is to take place and employed by the structural steel subcontractor. Survey shall show elevations and locations of base plates and anchor bolts to receive structural steel, and final elevations and locations for major members. Indicate discrepancies between actual installation and Contract Documents.

C. Reports:

1. Submit three certified mill test reports of chemical analysis and physical test for:
   a. Structural Steel
   b. Bolts, nuts, and washers
   c. Direct tension indicators
d. Shear stud connectors

e. Shop primer

f. Non-shrink grout

2. Submit anchor bolt checking certification as required.
3. Submit qualification certificates of all welders who will perform work on the project.

D. Calculations: For connections required by the Contract Documents to be selected or completed by the fabricator, provide engineering calculations prepared and sealed by a Registered Professional Engineer, licensed in the by the state in which the construction is to take place. Submit fabricator’s job standards and accompanying calculation prior to submission of steel shop drawings.

E. Certificates: Submit certification that materials to receive polyurethane coating system have received compatible surface preparation and priming.

F. LEED Submittals:
1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
   a. Include statement indicating costs for each product having recycled content.
2. Credit MR 5.1: List of proposed regionally manufactured materials and regionally extracted, harvested, or recovered materials.
   a. Identify each regionally manufactured material, its source, and cost.
   b. Identify each regionally extracted, harvested, or recovered material, its source, and cost.
   c. Include statement confirming the following, and identifying the nearest town for each indicated location.
      1) Distance between location of manufacture and Project site.
      2) Distance between location of extraction, harvesting, or recovery, and Project site.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to site at such intervals to ensure uninterrupted progress of work.

B. Deliver anchor bolts and anchorage devices with accompanying templates, which are to be embedded in cast-in-place concrete, in ample time not to delay work.

C. Store materials to permit easy access for inspection and identification. Keep steel members off ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

D. Do not store materials on structure in a manner that might cause distortion or damage to members of supporting structures. Repair or replace damaged materials or structures as directed.

1.07 TESTING AND INSPECTION
A. Inspection of all structural steelwork in the shop and field will be performed by an inspection agency retained by the Owner. The inspection agency shall work under the direction of the architect. The Owner shall provide the inspection agency with the following:

1. Schedule of all work in both shop and field with at least ten days written notice before commencement of either activity.
2. A complete set of approved shop and erection drawings.
3. Cutting lists, order sheets, material bills, shipping bills and mill test reports.
4. Information as to time and place of all rollings and shipment of material to shops.
5. Representative sample pieces as requested by the testing agency.
6. Full and ample means and assistance for testing all material.
7. Proper facilities, including scaffolding, temporary work platforms, etc., for inspection of the work in the mills, shop and field.

B. Each person installing connections shall be assigned an identifying symbol or mark and all shop and field connections shall be so identified so that the inspector can refer back to the person making the connection.

C. The following minimum criteria shall be adhered to in testing of welds and bolts:

1. All welds and bolts shall be examined by visual means.
2. 25% of all welds, selected randomly, shall be measured.
3. 25% of all pretensioned bolts, selected randomly, shall be checked with calibrated torque wrench.
4. In addition, all welds subject to tensile stress shall be examined by the Ultrasonic Method for 100% of their length.
5. 10% of all manual fillet welds shall be tested by the magnetic particle method.
6. 12-inches at each end of automatic fillet welds shall be tested by the magnetic particle method.
7. 100% of groove welds shall be tested by the ultrasonic method.

D. Shop inspection will include examination of steel for straightness and alignment, fissures, mill scale, and other defects and deformities, as described in ASTM A6, examination of fabricated pieces for conforming with approved shop drawings, testing of bolts and welds, and inspection of shop painting. All shop welds shall be visually inspected and spot tested using Ultrasonic Method ASTM E-114 and AWS, Chapter 6, Part C. All inspected welds shall be identified by the inspector.

E. Field inspection will include examination of erected steel for welding, proper fitting and tensioning of bolts, alignment, trueness and plumbness, touching-up of shop coat and level of base plates.

F. Inspection of welding will be such as to assure that the work is within the quality requirements specified below and elsewhere in this section of the specifications and will include:
1. Ascertainment that the electrodes used for manual shielded metal-arc welding and the electrodes and flux used for submerged arc-welding conform to the requirements of this section of the specifications.

2. Ascertainment that the approved welding procedures and sequence are followed without deviation, unless specific approval for change is obtained from the architect.

3. The testing agency shall be prepared to utilize the following approved methods of testing:

   a) Liquid penetrant inspection: ASTM E-165.
   c) Radiographic inspection: ASTM E-94, E-142, and E1032.
   d) Ultrasonic inspection: ASTM E-114 and AWS, Chapter 6, Section C.

G. When defects are revealed, additional inspection by whatever method is deemed necessary by the inspector, shall be performed to the extent necessary to assure that the full amount of defect has been located. No further work shall be done on the assembly or sub-assembly in question until all the necessary corrections have been made. Defects shall be repaired, using the same welding procedure that was used initially in making the weld, unless otherwise approved by the architect. Inspection of the repaired weld shall be by the same method that was used to reveal the defect. A second repair of a defective area shall not be made without approval of the architect.

H. Apparatus and procedure for measuring torque and tension in high strength bolts and for calibrating wrenches shall be furnished and maintained by steel contractor, and shall be approved by the inspection agency. Wrenches shall be calibrated each day of the beginning of the work, each time the bolt size or length of pressure hose is changed, and at such other times as the inspection agency may direct. Periodic checks of high strength steel bolt connections will be made in the field by the inspection agency. The steel contractor shall maintain at all times during erection a manual torque wrench, and shall provide a laborer and scaffolding as required for the testing of connections by the inspection agency, and shall at his own expense, furnish such facilities and provide such assistance as may be required for proper inspection.

I. A distinguishing mark will be placed on all work that has been inspected and approved. Material or work that is not acceptable will be designated by words such as "REJECT" or "REPAIR" marked directly on the material or work.

J. Inspection of Shop Painting:

1. Visually evaluate surface preparation by comparison with pictorial standards in accordance with SSPC-Vis 1.

2. Measure dry film thickness of each coat with a magnetic film thickness gauge in accordance with SSPC-PA 2.

3. Visually inspect dried film for runs, sags, dry spray, overspray and missed areas.

4. Repair defective or damaged areas in accordance with painting...
requirements specified. Architecturally exposed structural steel shall be free of runs and holidays. Make repairs to shop or field coat as directed.

1.08 COORDINATION REQUIREMENTS

A. The structural steel contractor shall coordinate the structural steel work with the work of other Contracts. Verify all dimensions and details of this Contract and those of other Contracts that affect the work before proceeding. Any discrepancies shall be immediately reported to the architect.

B. Be fully responsible for the accurate installation of the work. Any discrepancy which arises from his failure to execute the work in conformity to the drawings and specifications shall be properly remedied at the contractor’s own expense and in a manner acceptable to the architect.

C. Locate dimensionally on setting plans all anchor bolts, inserts, bearing and base plates, etc., and prepare and deliver all required templates and fully dimensioned setting plans in time for the proper execution of the work. Anchor bolts shall be set by another subcontractor. The structural steel contractor shall check all such settings for correctness after they have been cast in place, and before proceeding with erection work.

D. Report to the architect and certify compliance with the above checking requirements in writing and indicate any inaccuracies found in the location of anchor bolts or inserts, and corrections which must be made to their installation. Any inaccuracies not included in the report and found during or after steel erection shall be the responsibility of the structural steel contractor and the cost of corrective measures shall be borne by him.

E. Use base lines, bench marks, or other standards for survey work that have been provided or verified by others. If permanent building bench marks have been established, these will be used for field checking.

F. The structural steel subcontractor shall be fully responsible for all means, methods, techniques, sequences and procedures of construction. Coordinate with all other trades to insure that work of this section does not cause undue conflict. Insure that location of erection devices such as cranes, derricks, booms or hoists, does not cause overstresses to steel frame, to work previously placed by other trades or to existing structures. When required, retain the services of a professional engineer to ascertain that erection devices do not create unsafe conditions or cause overstresses.

1.09 SUBSTITUTION

A. Architect reserves the right to require substitute shapes of other sizes than those indicated on the drawings when it is apparent that the shapes specified cannot be furnished within the time required for the progress of construction. Make said substitutions without additional cost to the owner.

PART 2 - PRODUCTS
2.01 MATERIALS

A. Structural steel wide flange columns, girders, beams, and diagonal bracing: ASTM A992, or ASTM A572, Grade 50.

B. Miscellaneous steel shapes, plates, stiffeners, and base plates: ASTM A36.

C. Anchor Bolts: ASTM F1554, Grade 55.

D. Pipe Sections: ASTM A501 or ASTM A53, Grade B.

E. Structural Tube (HSS-Hollow Structural Sections): ASTM A500, Grade B.

F. Stainless Steel Hanger Rods and Connection Plates: ASTM A564 Type 17-4PH with a minimum yield strength of 50 ksi.

G. High Strength Bolts: ASTM A325 “bearing-type”, with hardened washers. Provide mechanically galvanized bolts, nuts, washers, and shims at connections exposed to weather and at members supporting exterior masonry. Nuts and bolts at tension element connection to structure shall conform to ASTM A307, A325 and shall be the regular hexagon-bolt type, or as shown in the drawings. Round washers shall conform to American Standard B 27.2 type b. Washers in contact with high-strength bolt heads and nuts shall be hardened in accordance with ASTM Standard A325. Beveled washers shall be square, smooth and sloped so that contact surfaces with the bolt head and nut are parallel. The diameter of the hole of square-beveled washers shall be 1/16 inch greater than the bolt size for bolts smaller than one inch, and shall be 1/8 inch greater than the bolt size for bolts larger than one inch.

G. Unfinished Bolts: ASTM A307, with hexagonal heads and nuts.

H. Filler metal for welding electrodes: AWS Class E70 Series.

I. Structural steel primer paint: rust inhibitive primer conforming to TT-P-86, Type I; or Tnemec Exterior #10-99 or 88-555.

J. Headed Stud Shear Connectors: Equivalent to S3L by Nelson.

K. Direct Tension Indicators: ASTM F959, Type 325.

L. Welding Materials: AWS D1.1, type required for materials being welded.

M. Thermal Break: Koralath Shim – Engineered multi-polymer plastic to be used as a bearing material, a dielectric between dissimilar metals, strips, shims, spacers and accessories as noted in the Drawings

   a. Minimum Compressive Strength: 9000 psi.

N. Primer for Polyurethane Coating System: Zinc-rich primer complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat. Use primer with VOC
content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Acceptable products and manufacturers:
   a. Carbozinc 11 VOC by Carboline Company.
   c. 90-97 Tneme-Zinc by Tnemec Company, Inc.

PART 3 - EXECUTION

3.01 FABRICATION

A. All shop connections shall be welded or high strength bolted unless specifically shown otherwise. Fabricate work in shop in as large assemblies as practicable.

B. Camber: All beams, girders (except cantilevers) and other members shall be fabricated with natural camber up.

C. Mill column ends and bearing stiffeners to give full bearing over the cross section. Plane contact surfaces of bearing plates when required by the AISC Specifications. It is not necessary to plane bottom surfaces of plates on grout beds.

D. Drill or punch holes at right angles to the surface of the metal, not more than 1/16" larger than the connector diameter. Do not make or enlarge holes by burning. Drill material having a thickness in excess of the connector diameter and material thicker than 7/8". Holes shall be clean-cut without torn or ragged edges. Remove outside burrs resulting from drilling operations.

E. Provide holes in members to permit connection of the work of other trades. Use suitable templates for proper location of these holes. Steel requiring adjustment or accurate alignment shall be provided with slotted holes or full bearing shims as shown.

F. Provide holes, slots and openings required by other trades together with necessary reinforcing required. Use suitable templates for proper location of these openings. All such openings shall be shown on the shop drawings. No change in size or location will be permitted without prior approval.

G. Cutting: Cut metal by sawing, shearing or blanking. Flame cutting will be permitted only if cut edges are ground back to clean, smooth edges. Make cuts accurate, clean, sharp, square and free of burrs, without deforming adjacent surfaces or metals. Manual flame cutting shall be done only with a mechanically guided torch. An unguided torch may be used provided the cut is within 1/8" of the required line. Field burning is not permitted without written approval.

3.02 CONNECTIONS

A. Provide connections as shown on the contract drawings. Where connections are not detailed, the minimum connections shall comply with appropriate tables titled,
"Framed Beam Connections" shown in the AISC "Manual of Steel Construction" unless otherwise noted on the drawings. Use high strength bolts or welds unless otherwise shown.

B. For all composite beams, proportion and detail all connections on shop drawings to resist forces shown on design drawings. If no reactions are indicated on design drawings, design connections for non-composite beams to resist the end reaction shown in the AISC tables for Uniform Load Constants for Beams.

C. Bolting:

1. Bolts shall be of a length that will extend not less than 1/4" but not more than 1/2" beyond the nuts. Enter bolts into holes without damaging the thread.
2. Use “bearing-type” high-strength bolts as shown. Bolt heads and nuts shall rest squarely against the metal. Where structural members have sloping surface, bolted connections shall be provided with beveled washers to afford square seating or framing for bolt heads or nuts. At slip-critical connections with oversized or long-slotted holes, provide 5/16" thick plate washers completely covering holes. Bring members tightly together with sufficient high-strength "fitting-up" bolts, which shall be retightened as all the bolts are finally tightened. Manual torque wrenches will not be accepted for final tightening. Protect bolt heads from damage during placing. Final tightening of high-strength bolts shall be by properly calibrated power torque wrenches. Bolts that have been completely tightened shall be marked for identification.

D. Welding:

1. Do not begin structural welding until joint elements are inspected for surface preparation, fit-up, and cleanliness of surface to be welded and are then bolted or tacked in intimate contact and adjusted to dimensions shown on drawings, or both, with allowance for any weld shrinkage that is expected. No members are to be spliced without prior approval by the architect.
2. Pre-heat and interpass temperature shall be in accordance with Table 4.2 (including footnotes) of the AWS Code for Welding in Building Construction. The temperature shall be measured from the side opposite to that which the pre-heat is applied, where possible.
3. All groove welds shall be continuous and full penetration welds unless otherwise shown on the design drawings. Welds made without the aid of a back-up bar shall have their roots chipped, ground or roughened out to sound metal from the second side, before welding is done from the second side.
4. All welds shall be sound throughout. There shall be no crack in any weld or weld pass. Weld may be considered sound if it contains only slight porosity or fusion defects, which are well dispersed.
5. The heat, input, length of weld and sequence of weld shall be controlled to prevent distortions. The surfaces to be welded and the filler metals to be used shall be subject to inspection before any welding is performed.

E. Connection depth: Minimum depth of shear connections shall be half the depth of the beam or girder (d/2).
G. Moment Connections: Unless design moments are provided on the contract drawings, provide bolted or welded moment connections with sufficient capacity to develop the full moment capacity of the connected member. In event that two different members are moment connected, the moment connection shall develop the full moment capacity of the weaker member.

G. Drill or punch holes at right angles to the surface of the metal, not more than 1/16 in. larger than the connector diameter. Do not make or enlarge holes by burning. Drill material having a thickness in excess of the connector diameter and material thicker than 7/8 in. Holes shall be clean-cut without torn or ragged edges. Remove outside burrs resulting from drilling operations.

H. Mill column and bearing stiffeners to give full bearing over the cross section. Mill contact surfaces of bearing and base plate. It is not necessary to plane bottom surfaces of plates on grout beds.

3.03 PAINTING AND CLEANING

A. Remove all rust, scale, grease and other detrimental foreign matter in accordance with the Steel Structures Painting Council Specification SP-3, Power Tool Cleaning.

B. Immediately after surface preparation, apply structural steel primer paint where specified, in accordance with manufacturer's instructions and at a rate to provide dry film thickness of not less that 2.0 mils. Use painting methods, which result in full coverage of joints, corners, edges and exposed surfaces. Use type of primer paint as specified in "Materials" article above. Apply two coats to surfaces that will be inaccessible after erection.

C. Paint all structural steel in accordance with the foregoing specification, except as follows:

1. Steel which is to receive spray-on fireproofing.
2. Within 2" of field welds or welds made after paint is applied.
3. Within 3" of faying surfaces of high strength slip-critical bolts.
4. Machined surfaces and threaded parts required for adjustment of the structure. Protect these with suitable rust inhibiting coating, which may be removed after final installation of the work so that proper finished coatings may be applied.
5. Surfaces to be embedded in concrete or mortar. Extend priming of partially embedded members to depth of 2 inches.
6. Provide second coat of paint on all steel in unheated spaces, but not directly exposed to moisture.

D. Field Painting:

1. After erection, all damaged areas in shop coat, exposed surfaces of bolt heads, nuts and washers, and all field welds and unpainted areas adjacent to field welds and high strength bolts shall be painted with a "touch-up" application of same paint used in the shop coat and then painted with same
paint used for shop coat tinted another color. Retouch in field, any scraped, abraded, and unpainted surfaces. Painting shall be as specified for shop coats.

2. Structural steel which is to support mechanical equipment that is exposed to the weather shall be hot-dip galvanized. This application shall be the responsibility of the structural steel subcontractor. Touch up all heat affected or damaged coatings with zinc-rich paint.

E. Shop Priming for Polyurethane Coating System:

1. Shop prime items with primer for polyurethane coating system.
2. Preparation: Clean by SSPC-SP 1-63 "Solvent Cleaning" method, followed by SSPC-SP 6-63 "Commercial Blast Cleaning" method to remove loose mill scale and rust.
3. Apply prime coat as soon as possible after cleaning. Provide smooth, uniform dry film thickness of 2.5 to 3.5 mils, unless otherwise recommended by finish coat manufacturer.
4. Locations: Use for steel exposed to weather and at mansard roof framing

3.04 ERECTION

A. Verify field measurements prior to start of erection. Check the alignment and elevation of all column supports and location of all anchor bolts with transit and level instruments before starting erection. Notify architect of any errors. Obtain architect’s approval of methods proposed for correcting errors prior to proceeding with corrections and erection.

B. Bearing and column base plates shall be supported and aligned on steel wedges, shims, or leveling nuts. After the supported members have been plumbed and properly positioned by instrument and anchor nuts tightened, the entire bearing area under the plate shall be packed solidly with grout specified in the Cast-in-Place Concrete Section. Wedges and shims shall be set back a minimum of 3/4” from the edges of plates and shall be left in place. Leveling plates are not permitted for column base plates larger than 24” in dimension.

C. Plumbing, Leveling and Bracing:

1. Structural steel shall be erected true and level, and temporary bracing shall be introduced wherever necessary to provide for all loads to which the structure may be subjected, including equipment and the operation thereof. Such bracing shall be left in place as long as may be required for safety. No welding shall be done or bolts drawn up tight until structural steel has been properly aligned. Obtain approval for guy locations to assure lack of interference with operations of other trades.

D. Drifting:

1. Light drifting necessary to draw holes together will be permitted, but drifting of
unfair holes will not be permitted. Twist drills shall be used to enlarge holes as necessary to the next larger size; use next larger size bolts as required. Reaming that weakens the members, or makes it impossible to fill the holes properly or to adjust accurately after reaming, will not be allowed.

END OF SECTION 05120
SECTION 05 12 13 - ARCHITECTURALLY EXPOSED STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes architecturally exposed structural-steel framing.
1. Requirements in Division 05 Section "Structural Steel Framing" also apply to AESS framing.
2. Requirements in Division 05 Section "Metal Stairs" also apply to AESS framing at the Monumental Stair C.

B. Related Sections:
1. Division 01 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
2. Division 05 Section "Structural Steel Framing" for additional requirements applicable to AESS.
3. Division 05 Section "Structural Steel Framing" for the requirements for steel which is exposed in finished construction but which is not designated as "AESS."
4. Division 05 Section "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other metal items not defined as structural steel.
5. Division 05 Section "Metal Stairs" for additional requirements applicable to AESS stair fabrications.
6. Division 09 Section “Painting” for surface preparation and priming requirements, especially High Performance primers and paints for AESS steel.

1.3 DEFINITIONS

A. Architecturally Exposed Structural Steel: Structural steel designated as "architecturally exposed structural steel" or "AESS" in the Contract Documents, including, but not limited to the following:
1. Steel for the Monumental Stair designated as Stair C.
2. Pipe columns in the Lecture Hall, to receive High Performance finish.
3. Steel plate walls in Lecture Hall, to receive High Performance finish.
4. Steel plate ceiling panels and trim and structure (plate columns and wide flange beams) in Vestibule F105, to receive High Performance finish.
5. All other steel designated “AESS” on structural and architectural drawings and general notes.

1.4 ACTION SUBMITTALS

A. Shop Drawings: Show fabrication of AESS components. Shop Drawings for structural steel may be used for AESS provided items of AESS are specifically identified and requirements below are met for AESS.
1. Clearly identify all AESS members and note special quality, tolerance, surface preparation and painting requirements.
2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
3. Include embedment drawings.
4. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain. Indicate grinding, finish, and profile of welds.
5. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections. Indicate orientation of bolt heads.
6. Indicate exposed surfaces and edges and surface preparation being used.
7. Indicate special tolerances and erection requirements.

B. Samples: Submit samples of AESS to set quality standards for exposed welds.
   1. Two steel plates, 3/8 by 8 by 4 inches (9.5 by 200 by 100 mm), with long edges joined by a groove weld and with weld ground smooth.
   2. Steel plate, 3/8 by 8 by 8 inches (9.5 by 200 by 200 mm), with one end of a short length of channel, in size typical for this project, welded to plate with a continuous fillet weld and with weld ground smooth and blended.

1.5 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified fabricator.

1.6 QUALITY ASSURANCE
A. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category STD.

B. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

C. Mockups: Build mockups of AESS to set quality standards for fabrication and installation.
   1. Build mockup of portion of Stair C and steel plate wall in Lecture Hall as directed by Architect.
   2. Coordinate finish painting requirements with Division 09 painting Sections.
   3. Maintain mockups as a reference standard until the conclusion of construction.
   4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

D. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Use special care in handling to prevent twisting, warping, nicking, and other damage. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
   1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.8 PROJECT CONDITIONS
A. Field Measurements: Where AESS is indicated to fit against other construction, verify actual dimensions by field measurements before fabrication.

1.9 COORDINATION
A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.
PART 2 - PRODUCTS

2.1 BOLTS, CONNECTORS, AND ANCHORS

A. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, round-head assemblies, consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
1. Finish: Plain or Mechanically deposited zinc coating.

2.2 PRIMER

A. Primer: Comply with Division 09 painting Sections.

2.3 FABRICATION

A. Shop fabricate and assemble AESS to the maximum extent possible. Locate field joints at concealed locations if possible. Detail assemblies to minimize handling and to expedite erection.

B. In addition to special care used to handle and fabricate AESS, comply with the following:
1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, and roughness.
2. Grind sheared, punched, and flame-cut edges of AESS to remove burrs and provide smooth surfaces and edges.
3. Fabricate AESS with exposed surfaces free of mill marks, including rolled trade names and stamped or raised identification.
4. Fabricate AESS with exposed surfaces free of seams to maximum extent possible.
5. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
6. Fabricate with piece marks fully hidden in the completed structure or made with media that permits full removal after erection.
7. Fabricate AESS to the tolerances specified in AISC 303 for steel that is designated AESS.
8. Fabricate AESS to the tolerances specified in AISC 303 for steel that is not designated AESS.
9. Seal-weld open ends of hollow structural sections with 3/8-inch (9.5-mm) closure plates for AESS.

C. Curved Members: Fabricate indicated members to curved shape by rolling to final shape in fabrication shop.
1. Distortion of webs, stems, outstanding flanges, and legs of angles shall not be visible from a distance of 20 feet (6 m) under any lighting conditions.
2. Tolerances for walls of hollow steel sections after rolling shall be approximately 1/2 inch (13 mm).

D. Coping, Blocking, and Joint Gaps: Maintain uniform gaps of 1/8 inch (3.2 mm) with a tolerance of 1/32 inch (0.8 mm) for AESS.

E. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

F. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.
2.4 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened unless otherwise indicated as Slip critical.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work, and comply with the following:
   1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding specified tolerances.
   2. Use weld sizes, fabrication sequence, and equipment for AESS that limit distortions to allowable tolerances.
   3. Provide continuous, sealed welds at angle to gusset-plate connections and similar locations where AESS is exposed to weather.
   4. Provide continuous welds of uniform size and profile where AESS is welded.
   5. Grind butt and groove welds flush to adjacent surfaces within tolerance of plus 1/16 inch, minus 0 inch (plus 1.5 mm, minus 0 mm) for AESS.
   6. Remove backing bars or runoff tabs; back-gouge and grind steel smooth for AESS.
   7. At locations where welding on the far side of an exposed connection of AESS occurs, grind distortions and marking of the steel to a smooth profile aligned with adjacent material.
   8. Make fillet welds for AESS oversize and grind to uniform profile with smooth face and transition.

2.5 SHOP PRIMING

A. Shop prime steel surfaces except the following:
   1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
   2. Surfaces to be field welded.
   3. Surfaces to be high-strength bolted with slip-critical connections.
   4. Surfaces to receive sprayed fire-resistive materials.
   5. Galvanized surfaces.

B. Surface Preparation for Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   1. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
   2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
   1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Examine AESS for twists, kinks, warping, gouges, and other imperfections before erecting.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep AESS secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
   1. If possible, locate welded tabs for attaching temporary bracing and safety cabling where they will be concealed from view in the completed Work.

3.3 ERECTION

A. Set AESS accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
   1. Erect Category 1 AESS to the tolerances specified in AISC 303 for steel that is designated AESS.
   2. Erect Category 2 and Category 3 AESS to the tolerances specified in AISC 303 for steel that is not designated AESS.

B. Do not use thermal cutting during erection.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened unless otherwise indicated Slip critical.
   2. Orient bolt heads as indicated on Drawings or in same direction for each connection and to maximum extent possible in same direction for similar connections.

   1. Remove backing bars or runoff tabs; back-gouge and grind steel smooth for Category 1 and Category 2 AESS.
   2. Remove erection bolts in Category 1 and Category 2 AESS, fill holes, and grind smooth.
   3. Fill weld access holes in Category 1 and Category 2 AESS and grind smooth.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect AESS as specified in Division 05 Section "Structural Steel Framing." The testing agency will not be responsible for enforcing requirements relating to aesthetic effect.

B. Architect will observe AESS in place to determine acceptability relating to aesthetic effect.

3.6 REPAIRS AND PROTECTION

A. Remove welded tabs that were used for attaching temporary bracing and safety cabling and that are exposed to view in the completed Work. Grind steel smooth.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

C. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

3.7 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 05 12 13
SECTION 05 31 00 - STEEL DECK

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Roof deck.
   2. Composite floor deck.

1.2 SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings: Include layout and types of deck panels, anchorage details, reinforcing channels, pans, deck openings, special jointing, accessories, and attachments to other construction.

C. Product certificates.

D. Welding certificates.

E. Research/evaluation reports.

F. LEED Submittals:
   1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
      a. Include statement indicating costs for each product having recycled content.
   2. Credit MR 5.1: List of proposed regionally manufactured materials and regionally extracted, harvested, or recovered materials.
      a. Identify each regionally manufactured material, its source, and cost.
      b. Identify each regionally extracted, harvested, or recovered material, its source, and cost.
      c. Include statement confirming the following, and identifying the nearest town for each indicated location.
         1) Distance between location of manufacture and Project site.
         2) Distance between location of extraction, harvesting, or recovery, and Project site.

1.3 QUALITY ASSURANCE

B. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those steel deck units tested for fire resistance per ASTM E 119 by a testing and inspection agency acceptable to authorities having jurisdiction.
   1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
   2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.

C. AISI Specifications: Calculate structural characteristics of steel deck according to AISI's "Specification for the Design of Cold-Formed Steel Structural Members."

D. SDI Specifications: Comply with the Steel Deck Institute’s "Design Manual for Floor Decks and Roof Decks."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
   1. BHP Steel Building Products USA Inc.
   2. Consolidated Systems, Inc.
   3. Epic Metals Corp.
   4. Marilyn Steel Products, Inc.
   6. Roof Deck, Inc.
   7. United Steel Deck, Inc.
   8. Verco Manufacturing Co.
   9. Wheeling Corrugating Co.; Div. of Wheeling-Pittsburgh Steel Corp.

2.2 ROOF DECK

A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 29.
   1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G90 zinc coating.
2. Deck Profile: Type B
3. Profile Depth: As indicated on drawings.
4. Design Uncoated-Steel Thickness: As shown on the drawings.

2.3 COMPOSITE FLOOR DECK

A. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 29, the minimum section properties indicated, and the following:
1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, zinc coated thickness of G60.
2. Profile Depth: As indicated on drawings.
3. Design Uncoated-Steel Thickness: As indicated on drawings.
4. Provide slots for piercing hanger tabs typically.
5. Provide Vent Slot Area: At deck that is located below exterior paved areas and at the roof provide vent slots or slots for piercing hangers that provide 1/2 percent open area of deck surface minimum.

2.4 ACCESSORIES

A. Accessories: Steel deck manufacturer's standard accessory materials, including mechanical fasteners, closure strips, pour stops, and closures for deck.
B. Shear Connectors: ASTM A 108, Grades 1010 through 1020 headed stud type, cold-finished carbon steel, AWS D1.1, Type B, with arc shields.
C. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install deck panels and accessories according to applicable specifications and commentary in the Steel Deck Institute’s “Manual of Construction with Steel Deck,” manufacturer's written instructions, and requirements in this Section.
B. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
C. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
D. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to decking.

E. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of decking, and support of other work.

F. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
   1. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

G. Roof Deck Accessories: Install ridge and valley plates, finish strips, cover plates, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.

H. Shear Connectors: Weld shear connectors through deck to supporting frame according to AWS D1.1 and manufacturer's written instructions. Butt end joints of deck panels; do not overlap. Remove and discard arc shields after welding shear connectors.

I. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.

J. Floor Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of decking. Weld cover plates at changes in direction of floor deck panels, unless otherwise indicated.

K. Repairs and Protection:
   1. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

3.2 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing agency to perform field quality-control testing.

B. Field welds will be subject to inspection.

C. Shear connector stud welds will be tested and inspected according to AWS D1.1.

D. Remove and replace work that does not comply with specified requirements.
E. Additional testing and inspecting, at Contractor's expense, will be performed to
determine compliance of corrected work with specified requirements.

END OF SECTION 05310
SECTION 05 40 00 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Exterior non-load-bearing wall framing.
   2. Interior non-load-bearing wall framing.

B. Related Sections include the following:
   1. Division 05 Section "Metal Fabrications" for masonry shelf angles and connections.
   2. Division 06 Section “Sheathing” for nailable rigid insulation and sheathing at exterior non-load-bearing wall framing.
   3. Division 09 Section "Non-Structural Metal Framing" for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.
   4. Division 09 Section "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated.

1. Exterior Design Loads:
   b. Wind Loads: Criteria indicated on the details and structural drawings.
   c. Seismic Loads: Criteria indicated on the details and structural drawings.

2. Interior Design Loads:
   a. Dead Loads: Weights of materials and construction and any construction hung /supported from metal stud
   b. Internal Pressure Loads: 5psf out of plane.
   c. Seismic Loads: Criteria indicated on the details and structural drawings.

3. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
   a. Exterior Non-Load-Bearing Framing backing up stone and brick: Horizontal deflection of 1/600 of the wall height.
   b. Interior Non-Load-Bearing Framing backing up interior brick and stone veneer: Horizontal deflection of 1/600 of the wall height.

4. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
5. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
   a. Upward and downward movement of 1-1/2 inches.

B. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."
   1. Headers: Design according to AISI's "Standard for Cold-Formed Steel Framing - Header Design."
   2. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
   3. Design interior non-load-bearing framing to support stone and brick veneer where indicated in Drawings.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of cold-formed metal framing product and accessory indicated.

   B. LEED Submittals:
      1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

   C. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
      1. For all cold-formed metal framing designed to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer, registered in the Commonwealth of Pennsylvania, responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

   A. Qualification Data: For professional engineer and testing agency.

   B. Welding certificates.

   C. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products:
      1. Steel sheet.
      2. Expansion anchors.
      4. Mechanical fasteners.
      5. Vertical deflection clips.
      6. Horizontal drift deflection clips.
      7. Miscellaneous structural clips and accessories.

   D. Research/Evaluation Reports: For cold-formed metal framing.
1.6 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated.

D. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.


F. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

G. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."
   1. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

I. Coordination Meeting for Stone Anchorage Systems: Prior to submission of shop drawings and other required submittals for the stone veneer, stone anchorage systems, structural steel, miscellaneous steel and cold-formed metal framing, the General Trades Contractor shall hold a coordination meeting with the steel supplier, cold-formed metal framing supplier, stone supplier, stone installer, stone anchorage system engineer retained by the stone supplier and/or installer, cold-formed metal framing engineer, masonry subcontractor, Construction Manager and Architect to review and coordinate the anchorage systems for the interior and exterior stone. The initial meeting shall cover the following:
   1. Responsibilities and extent of work to be provided by each subcontractor, supplier and installer for the stone anchorage systems.
   2. Coordination of work to be provided by each subcontractor, supplier and installer for the stone anchorage systems.
   3. Review schedule of work to be provided by each subcontractor, supplier and installer for the stone anchorage systems.
   4. Impact of work to be provided by each subcontractor, supplier and installer for the stone anchorage systems on work by other contractors, subcontractors, installers and suppliers.
   5. Determine date(s) for follow-up meetings, if required, to complete coordination of the work to be provided by each subcontractor, supplier and installer for the stone anchorage systems.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.
B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cold-formed metal framing that may be incorporated into the Work include, but are not limited to, the following:

1. Allied Studco.
2. AllSteel Products, Inc.
3. Clark Steel Framing.
4. Dale/Incor.
5. Dietrich Metal Framing; a Worthington Industries Company.
6. MarinoWare; a division of Ware Industries.
7. SCAFCO Corporation.
9. Steeler, Inc.
10. United Metal Products, Inc.

2.2 MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: ST33H.
2. Coating: G90 or equivalent.

C. Steel Sheet for Vertical Deflection Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: 50, Class 1 or 2.
2. Coating: G90.

2.3 EXTERIOR & INTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch (18 gauge).

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch, (18 gauge).

C. Vertical Deflection Clips: Manufacturer's standard head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dietrich Metal Framing; a Worthington Industries Company.
   b. MarinoWare, a division of Ware Industries.
   c. SCAFCO Corporation
   d. The Steel Network, Inc.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal and lateral loads and transfer them to the primary structure, and as follows:
   1. Minimum Base-Metal Thickness: 0.0428 inch, 18 gauge.
   2. Flange Width: 1 inch plus the design gap for 1-story structures.

2.4 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
   1. Supplementary framing.
   2. Flat strap diagonal bracing.
   3. 1 ½ inch 16 gauge U channel bridging, 48 inches on center, unless otherwise noted.
   4. 1 ½ inch by 1 ½ inch x 16 gage clip angle supports for U channel bridging,
   5. Bracing, bridging, and solid blocking.
   7. Anchor clips.
   8. End clips.
   12. Joist hangers and end closures.
   13. Hole reinforcing plates.

2.5 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Anchor Bolts: ASTM F 1554, 55 (S1), weldable, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.

C. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.
E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.6 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A 780.

B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and 30-minute working time.

C. Shims: Load bearing, high-density multimonomer plastic, nonleaching.

D. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.7 FABRICATION

A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
   a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.
4. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.
C. Install load bearing shims or grout between the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations to ensure a uniform bearing surface on supporting concrete or masonry construction.
D. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL
A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.
B. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.
C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
   1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
D. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.
   1. Cut framing members by sawing or shearing; do not torch cut.
   2. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
      a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.

H. Securely screw attach rigid insulation and sheathing, specified in Division 07 Section “Sheathing,” on exterior framing members in accordance with the manufacturer’s and engineer’s written recommendations.

I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer’s standard punched openings.

J. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to top and bottom track, unless otherwise indicated. Space studs as follows:
   1. Stud Spacing: As determined by engineering analysis submitted for review, but not to exceed 16” o.c.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
   1. Install single-leg deflection tracks and anchor to building structure.
   2. Install double deep-leg deflection tracks and anchor outer track to building structure.
   3. Connect vertical deflection clips to studs and anchor to building structure.
   4. Connect drift clips to cold-formed metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
   1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 18 inches of single deflection track. Install a combination of flat, taut, steel sheet straps of width and thickness indicated and stud or stud-track solid blocking of width and thickness matching studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
      a. Install solid blocking at centers indicated on Shop Drawings.
2. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.

F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

3.5 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Remove and replace work where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

3.7 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

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SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Steel framing and supports for overhead doors.
2. Steel framing and supports for countertops.
3. Steel framing and supports for mechanical and electrical equipment.
4. Steel framing and supports for applications where framing and supports are not specified in other Sections.
5. Elevator machine beams and hoist beams.
6. Steel shapes for supporting elevator door sills.
7. Shelf angles.
8. Loose bearing and leveling plates for applications where they are not specified in other Sections.
9. Metal ladders including elevator pit ladders, areaway ladders, rooftop ladders and fire stair access ladders.
10. Steel column cover.
11. Perforated metal grille at interior wall base.
12. Steel column cover.

B. Products furnished, but not installed, under this Section:
1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Sections:
1. Division 03 Section "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Division 04 Section "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
3. Division 05 Section "Structural Steel Framing."
4. Division 05 Section "Metal Stairs."
5. Division 05 Section "Decorative Metal."
6. Division 05 Section "Ornamental Railings."

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance of Ladders: Provide ladders capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Paint products.
   2. Grout.

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

C. Shop Drawings: Show fabrication and installation details for metal fabrications.
   1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

D. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.

C. Welding certificates.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, “Metal Bar Grating Manual.”

B. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   3. AWS D1.6, "Structural Welding Code - Stainless Steel."
1.7 PROJECT CONDITIONS
A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.8 COORDINATION
A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
B. Coordinate installation of anchorages and steel weld plates and angles for casting into concrete. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL
A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS
A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
C. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.
D. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
E. Steel Tubing: ASTM A 500, cold-formed steel tubing.
F. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.
G. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
   2. Material: Cold-rolled steel, ASTM A 1008/A 1008M, structural steel, Grade 33; 0.0966-inch minimum thickness; unfinished, unless otherwise noted.
H. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.3 NONFERROUS METALS
D. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless-steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.

D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1.

E. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Eyebolts: ASTM A 489.

G. Machine Screws: ASME B18.6.3.


I. Wood Screws: Flat head, ASME B18.6.1.


L. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

M. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

N. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.

O. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Shop Primers: Provide primers that comply with Division 09 painting Sections.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.


F. Concrete: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete.

2.6 FABRICATION, GENERAL

A. Galvanizing Locations:
   1. Any exterior steel, whether in contact with exterior air or concealed within an exterior wall is to be hot-dip galvanized unless noted as stainless steel.
   2. Any interior steel is to be primed and painted.

B. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

H. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

I. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

J. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

C. Galvanize miscellaneous framing and supports where indicated.

D. Prime miscellaneous framing and supports with primer specified in Division 09 Section "High-Performance Coatings" where indicated.

2.8 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.
2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize shelf angles located in exterior walls.
D. Prime shelf angles located in exterior walls with primer specified in Division 09 Section "High-Performance Coatings."

E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.9 METAL LADDERS

A. General:
   1. Comply with ANSI A14.3 unless otherwise indicated.
   3. For elevator pit ladders, comply with ASME A17.1.

B. Steel Ladders:
   1. Space siderails 18 inches apart unless otherwise indicated.
   2. Space siderails of elevator pit ladders 12 inches apart.
   3. Siderails: Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges.
   4. Rungs: 3/4-inch- diameter or 3/4-inch- square steel bars.
   5. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
   6. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
   7. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
      a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
         1) IKG Industries, a division of Harsco Corporation; Mebac.
         2) SlipNOT Metal Safety Flooring, a W. S. Molnar company; SlipNOT.
   8. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than 3/4 inch in least dimension.
   9. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets.
   10. Galvanize exterior ladders, including brackets and fasteners.
   11. Prime exterior ladders, including brackets and fasteners, with zinc-rich primer.

2.10 METAL GRATINGS

A. Basis-of-Design Manufacturer: McNichols Co., or equal.

B. Electroforged Bar Grating, Welded construction:
   2. AKA Description: GW 150.
   4. Bearing Bar Spacing: 1.1875 inches o.c.
   5. Bearing Bar Depth: 1.5 inch.
   6. Bearing Bar Thickness: 0.1875 inches.
   7. Crossbar Spacing: 4 inches o.c.
   8. Spacing Description: 19-W-4.
   9. Percent Open Area: 77%.
10. Weight: 10.8 #/sf.
11. Panel size: 24"x240".
12. McNichols Item Number: 6402310122.

C. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.
1. Provide no fewer than four saddle clips for each grating section composed of rectangular bearing bars 3/16 inch (4.8 mm) or less in thickness and spaced 15/16 inch (24 mm) or more o.c., with each clip designed and fabricated to fit over two bearing bars.
2. Provide no fewer than four weld lugs for each grating section composed of rectangular bearing bars 3/16 inch (4.8 mm) or less in thickness and spaced less than 15/16 inch (24 mm) o.c., with each lug shop welded to three or more bearing bars. Interrupt intermediate bearing bars as necessary for fasteners securing grating to supports.
3. Secure grating to supports as indicated on Drawings.

D. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.

2.11 GRATING FRAMES AND SUPPORTS

A. Frames and Supports for Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
1. Unless otherwise indicated, fabricate from same basic metal as gratings.
2. Where frames and supports are aluminum to match aluminum gratings, separate metal from adjacent concrete, CMU and limestone with a layer of bituminous paint or neoprene spacer strips.
3. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches (600 mm) o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches (32 mm) wide by 1/4 inch (6 mm) thick by 8 inches (200 mm) long.

B. Galvanize steel frames and supports in the following locations:
1. Exterior.

2.12 PERFORATED METAL GRILLE

1. Perforated Metal Grille at Interior Wall Base:
a. Basis of Design: Provide Straight Slotted Perforated Sheet Metal Grille as manufactured by McNichols Co., or approved equal.
   1) Material: 18 ga. steel
   2) Perforation Size: ¼" x 1-1/2"
   3) Arrangement: Straight.
   4) Side and End Bars: 3/32"
   5) Open Area: 68%
   6) Finish: Prefinished matte black.
2.13 STEEL COLUMN COVER

A. Basis-of-Design Product: Subject to compliance with requirements, provide Series FF Column Cover by Fry Reglet Architectural Metals, or approved equal.
   1. Material: Steel.
   3. Type: Series FF Monolithic, Field Taped & Finished.
   4. Diameter: 20” diameter, with 18” recessed base; see details on Drawings.

2.14 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
   1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize exterior miscellaneous steel trim.

D. Prime exterior and interior miscellaneous steel trim with zinc-rich primer.

2.15 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates.

2.16 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches unless otherwise indicated.

C. Galvanize loose steel lintels located in exterior walls.

2.17 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.
2.18 FRAMING FOR INTERIOR ARCHITECTURAL WOODWORK

A. Shop fabricate and assemble framing for interior architectural woodwork to the maximum extent possible. Locate field joints at concealed locations, if possible. Detail assemblies to minimize handling and to expedite erection.

B. Fabrication:
1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale and roughness.
2. Grind sheared, punched, and flame cut edges to remove burrs and provide smooth surfaces and edges.
3. Fabricate with exposed surfaces free of mill marks, including rolled trade names and stamped or raised identification.
4. Fabricate with exposed surfaces free of seams to maximum extent possible.
5. Remove blemishes by filing or grinding or by welding and grinding, before cleaning, treating, and shop priming.
6. Fabricate with piece marks fully hidden in the completed structure or made with media that permits full removal after erection.
7. Seal weld open ends of hollow structural sections with 3/8 inch closure plates.
8. Bolt holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces. Do not thermally cut bolt holes or enlarge holes by burning.

C. Welding:
1. Install filler material at stitch welded connections for a finished appearance of a continuous welded connection.

2.19 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.20 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
1. Shop prime with primers specified in Division 09 painting Sections unless indicated.

C. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
3. Decorative Metal, Decorative Metal Railings, and other steel fabrications exposed in finish construction: Refer to Division 05 Sections “Decorative Metal,” or “Decorative Metal Railings.”


5. Other Items: SSPC-SP 3, "Power Tool Cleaning."

D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.21 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

2.22 STAINLESS STEEL FINISHES

A. Remove tool and die marks and stretch lines or blend into finish.

B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

C. Dull Satin Finish: No. 6.

D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.

1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING BEARING AND LEVELING PLATES


B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations unless otherwise indicated.

2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 05 50 00
SECTION 05 51 00 - METAL STAIRS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Preassembled steel stairs with concrete-filled treads.
2. Steel railings attached to metal stairs.
3. Steel tube handrails attached to walls adjacent to metal stairs.
4. Railing gates at the level of exit discharge.
5. Steel tube handrails noted on Drawings but not associated with stairs.

B. Related Sections:

1. Division 03 Section "Cast-in-Place Concrete" for concrete fill for stair treads and platforms.
2. Division 05 Section "Metal Fabrications" for metal ladders.
3. Division 05 Section "Decorative Metal Railings" for ornamental metal railings.
4. Division 05 Section "AESS" for Monumental Stair C.
5. Division 09 Section "Non-Structural Metal Framing" for metal backing for anchoring railings.
6. Division 09 Section "Stone Flooring" for stone treads and landings for ornamental steel-framed stairs.
7. Division 09 Sections "Painting" and for primers and paint finishes.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Uniform Load: 100 lbf/sq. ft.
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.

C. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
1. Handrails Assemblies and Guards:
   a. Uniform load of 50 lb/ft applied in any direction, and to transfer that load through the supports to the structure.
   b. Concentrated load of 200 lb applied in any direction along the top, and to have attachment devices and supporting structure to transfer this loading to appropriate structural elements of the building.
   c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:
   a. Concentrated load of 200 lb applied horizontally on an area of 1 sq. ft.
   b. Uniform load of 50 lb/sq ft applied horizontally.
   c. Infill load and other loads need not be assumed to act concurrently.

D. Seismic Performance: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. Component Importance Factor is 1.25.

1.4 ACTION SUBMITTALS

A. Product Data: For metal stairs and the following:
   1. Prefilled metal-pan stair treads.
   2. Metal floor plate treads.
   3. Paint products.

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Provide templates for anchors and bolts specified for installation in other Sections.
   2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   3. For items indicated to conform to performance requirements and design criteria, shop drawings shall be signed and sealed by a qualified professional engineer.

D. Samples for Initial Selection: For products involving selection of color, texture, or design.

E. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, submit analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer and testing agency.
B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for stairs and railings.

1. Test railings according ASTM E 894 and ASTM E 935.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.

1. Preassembled Stairs: Commercial class for enclosed fire stairs.
2. Industrial-Type Stairs: Industrial class.
3. Ornamental Stairs: Architectural class.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.7 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
2.2 **FERROUS METALS**

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Steel Tubing: ASTM A 500 (cold formed).

D. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25, unless another grade is required by design loads; exposed.

E. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 coating, either commercial steel, Type B, or structural steel, Grade 33, unless another grade is required by design loads.

F. Perforated Metal: Cold-rolled steel sheet, ASTM A 1008/A 1008M, or hot-rolled steel sheet, ASTM A 1011/A 1011M, commercial steel Type B, 0.060 inch thick, with 1/4-inch round holes @ 3/8 inch o.c. in staggered rows.

2.3 **FASTENERS**

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

   1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for stairs indicated to be galvanized.

D. Machine Screws: ASME B18.6.3.

E. Lag Screws: ASME B18.2.1.


H. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

   1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Shop Primers: Provide primers that comply with Division 09 painting Sections.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.


F. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.

2.5 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
   1. Join components by welding unless otherwise indicated.
   2. Use connections that maintain structural value of joined pieces.
   3. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.

B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Weld exposed corners and seams continuously unless otherwise indicated.
   5. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

H. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

### 2.6 STEEL-FRAMED STAIRS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alfab, Inc.
2. American Stair, Inc.
3. Sharon Companies Ltd. (The).

B. Stair Framing:

1. Fabricate stringers of steel channels.
   a. Provide closures for exposed ends of channel stringers.

2. Construct platforms of steel plate or channel headers and miscellaneous framing members as needed to comply with performance requirements.

3. Weld stringers to headers; weld framing members to stringers and headers.

4. Where stairs are enclosed by gypsum board shaft-wall assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

C. Metal-Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.067 inch.

1. Steel Sheet: Uncoated cold-rolled steel sheet unless otherwise indicated.
2. Steel Sheet: Galvanized-steel sheet, where indicated.
3. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
4. Shape metal pans to include nosing integral with riser.
5. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.

### 2.7 STAIR RAILINGS

A. Steel Railings: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.

1. Rails and Posts: as indicated in the Drawings. For stairs in mechanical rooms and other non-public places which are not detailed in Drawings, provide 1-1/2-inch diameter round top and bottom rails and 1-1/2-inch square posts.
2. Picket Infill: as indicated in the Drawings. For stairs in mechanical rooms and other non-public places which are not detailed in Drawings, provide 1/2-inch- square pickets spaced less than 4 inches clear.

3. Gates: Construct gate as shown on Drawings, with perforated metal sheet infill. Provide each gate with two Partsko cast stainless steel round barrel gravity hinge, #656-8056. Provide overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.

B. Welded Connections: Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Finish welds at mechanical room stairs which are in non public areas to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 3 welds: partially dressed weld with spatter removed.

C. Form changes in direction of railings as follows:

1. By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.

D. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

E. Close exposed ends of railing members with prefabricated end fittings.

F. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.

G. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.

1. Connect posts to stair framing by direct welding unless otherwise indicated.
2. For galvanized railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
3. For nongalvanized railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.

H. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.8 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal stairs after assembly.
C. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
   1. ASTM A 123/A 123M, for galvanizing steel and iron products.
   2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
   3. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
   4. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed products:
   1. Interior Stairs: SSPC-SP 3, "Power Tool Cleaning."

E. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

F. Field Welding: Comply with requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
4. At exposed conditions, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

G. Place and finish concrete fill for treads and platforms to comply with Division 03 Section "Cast-in-Place Concrete."

3.2 INSTALLING RAILINGS

A. Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:

1. Anchor posts to steel by welding directly to steel supporting members.
2. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with postinstalled anchors and bolts.

B. Attach handrails to wall with wall brackets. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt. Provide bracket with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
2. For hollow masonry anchorage, use toggle bolts.
3. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed steel reinforcements using self-tapping screws of size and type required to support structural loads.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.4 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
1. Aluminum.
2. Plastic Materials
3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 05 51 00
SECTION 05 70 00 - DECORATIVE METAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Decorative metal extrusions, plates, and other trim pieces.
   2. Perforated ss metal panels.

B. Related Sections:
   1. Division 05 Section "Metal Fabrications" for non-decorative metal fabrications.
   2. Division 05 Section "Ornamental Railings" for stainless steel fittings used with glass railings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including finishing materials.

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

C. Shop Drawings: Show fabrication and installation details for decorative metal.
   1. Include plans, elevations, component details, and attachments to other work.
   2. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

D. Samples for Initial Selection: For products involving selection of color, texture, or design.

E. Samples for Verification: For each type of exposed finish required.
   1. Sections of linear shapes.
   2. Samples of welded joints showing quality of workmanship.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified fabricator and anodic finisher.

B. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing decorative metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
B. Installer Qualifications: Fabricator of products.

C. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

D. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   4. AWS D1.6, "Structural Welding Code - Stainless Steel."

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockups for the following types of decorative metal:
      a. Include all required anodized aluminum extrusions and plates, as shown in Drawings, in mockup for corrugated aluminum ceiling constructed from Aero material specified in Division 09 Section “Interior Metal Surfaces.” Extent of mockup to as directed by Architect.
   2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 COORDINATION

A. Coordinate installation of anchorages for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. Provide materials without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

2.2 ALUMINUM

A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
B. Extruded Bars and Shapes: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.

C. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 5005-H32.


2.3 STAINLESS STEEL

A. Tubing: ASTM A 554, Grade MT 304, unless otherwise indicated.

B. Pipe: ASTM A 312/A 312M, Grade TP 304, unless otherwise indicated.

C. Castings: ASTM A 743/A 743M, Grade CF 8 or CF 20, unless otherwise indicated.

D. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304, unless otherwise indicated.

E. Bars and Shapes: ASTM A 276, Type 304, unless otherwise indicated.

F. Perforated Plate: ASTM A 666, Type 304
   1. 3/16” thick plate with perforation pattern as shown in Drawings.

2.4 FASTENERS

A. Fastener Materials: Unless otherwise indicated, provide the following:
   1. Aluminum Items: Type 304 stainless-steel fasteners.
   2. Stainless-Steel Items: Type 304 stainless-steel fasteners.
   3. Dissimilar Metals: Type 304 stainless-steel fasteners.

B. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.

C. Provide concealed fasteners for interconnecting components and for attaching decorative metal items to other work unless otherwise indicated.
   1. Provide square drive countersunk machine screws for exposed fasteners unless otherwise indicated.

D. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

E. Post-Installed Anchors: Torque-controlled expansion type or chemical type.
   1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 unless otherwise indicated.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
   1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
2.6 FABRICATION, GENERAL

A. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

B. Form decorative metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

D. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.

E. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

F. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.

G. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.

H. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.

I. Comply with AWS for recommended practices in shop welding. Weld behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded joints of flux, and dress exposed and contact surfaces.

1. Where welding cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 Welds: no evidence of a welded joint.

2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.8 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

1. Texture: Matte finish.
2.9 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   1. Run grain of directional finishes with long dimension of each piece.

C. Dull Satin Finish: No. 6.

D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Provide anchorage devices and fasteners where needed to secure decorative metal to in-place construction.

B. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.

C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.

D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

E. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.

F. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.
   1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.

G. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

H. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
3.3 CLEANING AND PROTECTION

A. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.

B. Protect finishes of decorative metal from damage during construction period with temporary protective coverings approved by decorative metal fabricator. Remove protective covering at time of Substantial Completion.

C. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

3.4 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
   1. Separate tempered glass waste for use as aggregate of nonstructural fill.

C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 05 70 00
SECTION 05 72 10 - ORNAMENTAL RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Laminated glass guardrail for monumental stair.
2. Other laminated glass guard rails not associated with stair as indicated in the Drawings.
3. Stainless-steel decorative railings attached to glass guardrail.
4. Stainless-steel decorative railing attached to wall.
5. Glass draft curtain and recessed mounting shoe.
6. Fabricated specialty stainless steel fittings, attachments, brackets and hardware for anchorage associated with guard rails and hand rails as indicated on construction drawings.
7. All glass and glazing work required as part of ornamental railings shall be provided and installed as work of this Section, but shall also comply with the requirements of Division 8 Section “Glazing.”

B. Work under this Section consists of furnishing all labor, materials, equipment and services necessary for, and incidental to, the complete and proper fabrication, erection, and installation of all ornamental railings and related work as shown on the drawings or specified herein, and in accordance with all applicable requirements of the Contract Documents.

C. The material and installation shall conform to the applicable building code and other requirements of all authorities having jurisdiction.

D. Related Sections:
1. Division 8 Section “Glazing”.
2. Division 5 Section “Arch Exposed Structural Steel” for ornamental steel framed stair.
3. Division 9 Section “Stone Flooring” for stair treads and risers.

1.3 DEFINITIONS

A. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor areas, pedestrian guidance and support, visual separation, or wall protection.

B. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes such as glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer’s written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.4 PERFORMANCE REQUIREMENTS

A. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
1. Stainless Steel: 60 percent of minimum yield strength.
2. Steel: 72 percent of minimum yield strength.
3. Glass: 25 percent of mean modulus of rupture (50 percent probability of breakage), as listed in "Mechanical Properties" in AAMA's Aluminum Curtain Wall Series No. 12, "Structural Properties of Glass."

B. The Contractor shall engineer ornamental railing fabrications and connections required by the Contract Documents to be capable of withstanding the effects of live loads, gravity loads and other loads and stresses within limits required and under conditions indicated for the materials or equipment to be supported.
1. Design ornamental railing fabrications and glass to withstand design loads without vertical or lateral deflections that exceed the tolerances required by the materials or equipment being supported.
2. The Contractor shall account for all the loads imposed on the system including self weight, wind loads and seismic loads in accordance with the local building code.

C. Engineering Responsibility: All ornamental metalwork and glass shall be designed by a Structural Engineer licensed in the State of Pennsylvania and retained by the Contractor. The system shall be fabricated and erected under the direction of a Structural Engineer licensed in the State of Pennsylvania and retained by the Contractor. The Contractor shall submit shop drawings and structural calculations prepared, stamped and signed by a Pennsylvania Registered Structural Engineer to the Design Engineer for review and approval by the Building Department, and must obtain a permit prior to construction.

D. Structural Performance: Glass and metal railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Handrails and Top Rails of Guards:
   a. Uniform load of 50 lbf/ft. applied in any direction.
   b. Concentrated load of 200 lbf applied in any direction.
   c. Uniform and concentrated loads need not be assumed to act concurrently.
2. Infill of Guards:
   a. Concentrated load of 200 lbf applied horizontally on an area of 1 sq. ft.
   b. Infill load and other loads need not be assumed to act concurrently.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

F. Design ornamental metalwork fabrications and glass to accommodate deflection of primary buildings structure and construction tolerances.

G. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.5 SUBMITTALS
A. General: Submit the following in accordance with Conditions of the Contract and Division 1 Specification Sections.

B. Product Data: For each type of product indicated, including finishing materials.
C. Shop Drawings:

1. Shop drawings shall be prepared under the supervision of a professional engineer licensed in
   Pennsylvania and shall have the signature and seal of the professional engineer in that
   jurisdiction.

2. Include plans, elevations, component details, and attachments to other work. Provide the
   following information:
   a. Tolerances
   b. Profiles of members
   c. Anchorage system
   d. Field welding
   e. Connections and Fasteners
   f. Provisions for expansion and contraction
   g. Set-out of all work, including reference points, edge conditions, and joint pattern,
      indicated on plans, elevations, and sections as applicable.
   h. Framing, anchorages, and fixings supported from base-structure, and embeddings in
      the base-structure, if required.
   i. Methods of assembly at all junctions indicated by three –dimensional and exploded
      views if requested.

3. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes,
   fasteners, anchorages, and accessory items.

4. Include details of cuts, connections, splices and other pertinent data.

5. For installed products indicated to comply with design loads, include structural analysis data
   signed and sealed by the qualified professional engineer responsible for their preparation.

6. Shop drawings shall show layout, spacings, sizes, thicknesses and types of ornamental
   metalwork, fabrication, fastening and anchorage details, including welded connections and
   mechanical fasteners. Indicate materials, profiles of each member and fitting, joinery,
   connection details, finishes, fasteners, anchorages and accessory items. Show reinforcing,
   supplemental framing, bracing, bridging, splices and attachments to other units of Work, and
   other details required for proper installation.

7. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and
   show size, length, and type of each weld. Clearly indicate finishing and polishing
   requirements for welds that will be exposed in finish work.

8. Field verify existing conditions, prior to commencing drawings.

D. Samples for Initial Selection: For products involving selection of color, texture, or design,
   including mechanical finishes.

E. Samples for Verification: For each type of exposed finish required.

1. Each type of glass required.
2. Fittings and brackets.
3. Welded connections.
4. Assembled Samples of railing systems, made from full-size components.

F. Qualification Data: For qualified professional engineer.

G. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products
   furnished comply with requirements.

H. Welding certificates.

I. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing
   agency, according to ASTM E 894 and ASTM E 935.

J. Preconstruction test reports.
1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of railing from single source from single manufacturer.

B. Source Limitations for Clear Low-Iron Glass: Where Low-Iron glass is specified in the Glass Schedule, Contractor shall coordinate fabricators to procure low-iron float glass from one primary-glass source.
   1. Acceptable Manufacturers include the following:
      b. Pilkington: “Optiwhite” (www.lof.com)

C. Source Limitations for Laminated Glass: Obtain laminated-glass units from one manufacturer using the same type of glass lites and interlayers for each type of unit indicated.

D. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including structural analysis, preconstruction testing, field testing, and in-service performance.
   1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

E. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.6, "Structural Welding Code - Stainless Steel."

F. Safety Glazing Labeling: Permanently mark glass with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer’s name, type of glass, thickness, and safety glazing standard with which glass complies.

G. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockups for each form and finish of railing consisting of handrail, structural glazing, and anchorage system components that are full height and are not less than 24 inches in length.
   2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

H. Pre-installation Conference: Conduct conference at Project site with ornamental metal and railing manufacturer, installer, Contractor, Architect, Structural Engineer and other interested parties to review procedures, schedules, and coordination of installation of other elements of the work.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 COORDINATION AND SCHEDULING

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not suit structural performance requirements.

1.9 WARRANTY

A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Manufacturer's Special Warranty on Laminated Glass: Written warranty, made out to Owner and signed by laminated-glass manufacturer agreeing to furnish replacements for laminated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.

2.2 STAINLESS STEEL

A. Tubing: ASTM A 554, Grade MT 304

B. Pipe: ASTM A 312/A 312M, Grade TP 304

C. Castings: ASTM A 743/A 743M, Grade CF 8 or CF 20

D. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304

E. Bars and Shapes: ASTM A 276, Type 304

2.3 GLASS DRAFT CURTAIN SHOE

A. Basis of Design: Provide two-piece mounting bracket SB-200 by Blumcraft, or equal.
   a. Two piece mounting bracket isolates glass panels from shock of building movement.
   b. Provide readily accessible bolts for easy glass panel replacement.
   c. Mandatory bonding of SB-200 base to glass at factory under controlled conditions.
   d. Install per manufacturer's instructions and according to the Drawings.

2.4 GLASS AND GLAZING MATERIALS

A. Tempered Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated), Type 1 (transparent flat glass), Quality-Q3. Provide products that have been tested for surface and edge
compression according to ASTM C 1048 and for impact strength according to 16 CFR 1201 for Category II materials.

1. Glass Color: Clear
2. Thickness for Structural Glass Balusters: As required by structural loads.

B. Glazing Gaskets and Bushings: Clear silicone.

C. GLASS

2. Quality Control: All glass shall be manufactured and processed in a factory where the quality control procedures comply with ISO 9002 and are independently maintained.
3. Defects: The glass shall be cut clean, without edge faults such as feathered edges, shells or other imperfections. In all structural applications such as glass fins or point-supported glass and with all toughened glass, all edges shall be ground to eliminate edge defects.
4. Manufacturing Tolerances - In general as set out by ASTM C1036 -
   a. Minimum Actual Glass Thickness for Nominal Specified Glass Thickness:
   b. Not less than those specified in ASTM E 1300 Table A4.1
5. Fabrication Tolerances:
   a. Thickness <6mm (1/4") 8 & 10mm (5/16" & 3/8") 12 (1/2" & 15mm (5/8")
   b. Warp: ±0.196" per yard measured along straight edge
   c. Any dim. < 3'-3" ±0.04" ±0.08" ±0.08"
   d. Any dim. > 3'-3" ±0.04" ±0.08" ±0.11" 
   e. Squareness shall be measured by a comparison of diagonals.
   f. Diagonals up to 78.74": ±0.15".
   g. Diagonals over 78.74": ±0.19".
   h. Edge straightness: ±0.036" per foot
6. All glass shall be prefabricated and delivered in the required sizes. No on-site cutting, nipping or drilling will be allowed.
7. Edge working: All edges shall be ground and polished unless specifically indicated otherwise on construction documents.

D. LAMINATED GLASS

1. Laminated Glass: Comply with ASTM C 1172 for kinds of laminated glass indicated and other requirements specified.
2. Interlayer: Interlayer material as indicated below, clear or in colors, and of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.
   a. Interlayer Material: cured resin or Polyvinyl butyral sheets, including Sentry Glass Plus (DUPONT).
3. Laminating Process: Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets as follows:
   a. Laminate lites with polyvinyl butyral interlayer in autoclave with heat plus pressure.
   b. Laminate lites with laminated glass manufacturer's standard cast-in-place and cured transparent resin interlayer.
4. Glass Thickness: Drawings indicate 1" thick glass. It is the responsibility of the Designated Design Engineer to verify glass thickness and notify Architect of any variations.
2.5 FASTENERS

A. Fastener Materials: Unless otherwise indicated, provide the following:
   1. Stainless-Steel Components: Type 304 stainless-steel fasteners.

B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless exposed fasteners are unavoidable.

D. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

2.6 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

F. Welded Connections:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove flux immediately.
   4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.

G. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

H. Form changes in direction as follows:
   1. As detailed.

I. Close exposed ends of hollow railing members with prefabricated end fittings.

J. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns, unless clearance between end of rail and wall is 1/4 inch or less.
K. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

L. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

2.7 GLAZING PANEL FABRICATION

A. General: Fabricate to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.

1. Clean-cut or flat-grind edges at butt-glazed sealant joints to produce square edges with slight chamfers at junctions of edges and faces
2. Grind smooth exposed edges, including those at open joints, to produce square edges with slight chamfers at junctions of edges and faces.

2.8 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM’s "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.9 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.

C. Dull Satin Finish: No. 6.

D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.
B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
C. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 INSTALLING GLASS PANELS

A. Glass-Supported Railings: Install assembly to comply with railing manufacturer's written instructions.

1. Adjust spacing of glass panels so gaps between panels are equal before securing in position.
B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

3.4 CLEANING

A. Clean aluminum and stainless steel by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.
B. Clean and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.
3.5 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

C. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer.

3.6 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
   1. Separate tempered glass waste for use as aggregate of nonstructural fill.

C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 05 72 10
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
1. Rooftop equipment bases and support curbs.
2. Wood blocking, cants, and nailers.
3. Wood furring and grounds.
4. Plywood sheathing and backing panels.
5. Spaced board sheathing over furring for slate shingle roof.
6. Concealed plywood blocking for shelving.

B. Related Requirements:
1. Division 01 Section "LEED Requirements" for additional LEED requirements.
2. Division 06 Section "Sheathing."

1.3 DEFINITIONS
A. Exposed Framing: Framing not concealed by other construction.

B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.

C. Lumber grading agencies, and the abbreviations used to reference them, include the following:
2. NLGA: National Lumber Grades Authority.
3. RIS: Redwood Inspection Service.
5. WCLIB: West Coast Lumber Inspection Bureau.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. LEED Submittals:
1. Certificates for Credit MR 7: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
2. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.
3. Product Data for Credit IEQ 4.4: For composite wood products, documentation indicating that product contains no urea formaldehyde.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

B. Evaluation Reports: For the following, from ICC-ES:
1. Wood-preservative-treated wood.
2. Fire-retardant-treated wood.
5. Expansion anchors.
6. Metal framing anchors.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Certified Wood: Materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
3. Provide dressed lumber, S4S, unless otherwise indicated.

C. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
1. For exposed lumber indicated to receive a stained or natural finish, omit marking and provide certificates of treatment compliance issued by inspection agency.

D. Application: Treat items indicated on Drawings, and the following:
1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
1. Use treatment that does not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber shall be tested according ASTM D 5664 and design value adjustment factors shall be calculated according to ASTM D 6841.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
   1. For exposed lumber indicated to receive a stained or natural finish, omit marking and provide certificates of treatment compliance issued by testing agency.

E. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat all rough carpentry unless otherwise indicated.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
   1. Blocking.
   2. Nailers.
   3. Rooftop equipment bases and support curbs.
   5. Furring.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species.

C. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:
   1. Mixed southern pine; No. 2 grade; SPIB.
   2. Hem-fir or hem-fir (north); Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
   3. Spruce-pine-fir (south) or spruce-pine-fir; Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
   4. Eastern softwoods; No. 2 Common grade; NeLMA.
   5. Northern species; No. 2 Common grade; NLGA.
   6. Western woods; Construction or No. 2 Common grade; WCLIB or WWPA.

D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

F. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) nominal thickness.
2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.


D. Wood Screws: ASME B18.6.1.

E. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).

F. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

2.7 MISCELLANEOUS MATERIALS

A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

B. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

C. Do not splice structural members between supports unless otherwise indicated.

D. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
   1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.
E. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

F. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
   1. Use inorganic boron for items that are continuously protected from liquid water.
   2. Use copper naphthenate for items not continuously protected from liquid water.

G. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. NES NER-272 for power-driven fasteners.

H. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

I. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.
   1. Comply with approved fastener patterns where applicable. Before fastening, mark fastener locations, using a template made of sheet metal, plastic, or cardboard.
   2. Use finishing nails unless otherwise indicated. Countersink nail heads and fill holes with wood filler.

3.2 WOOD GROUND, SLEEPER, BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

C. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

3.3 WOOD FURRING INSTALLATION

A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal- (19-by-63-mm actual-) size furring horizontally at 24 inches (610 mm) o.c.

C. Furring to Receive Gypsum Board: Install 1-by-2-inch nominal- (19-by-38-mm actual-) size furring vertically at 16 inches (406 mm) o.c.

3.4 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

3.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 06 10 00
SECTION 06 16 00 – SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Wall sheathing.
   2. Roof sheathing.
   3. Underlayment.

B. Related Requirements:
   1. Division 06 Section "Rough Carpentry" for plywood backing panels.
   2. Division 07 Section "Fluid-Applied Membrane Air Barrier" for water-resistant barrier applied over wall sheathing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
   3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5516.
   4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
   5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. LEED Submittals:
   1. Certificates for Credit MR 7: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
   2. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.
   3. Product Data for Credit IEQ 4.4: For composite wood products, documentation indicating that product contains no urea formaldehyde.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For following products, from ICC-ES:
   1. Preservative-treated plywood.
   2. Fire-retardant-treated plywood.
1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.


2.2 WOOD PANEL PRODUCTS

A. Certified Wood: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":

1. Plywood.

B. Plywood: Either DOC PS 1 or DOC PS 2 unless otherwise indicated.

C. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

D. Factory mark panels to indicate compliance with applicable standard.

2.3 PRESERVATIVE-TREATED PLYWOOD

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

C. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

2.4 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-
response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber plywood shall be tested according ASTM D 5516 and design value adjustment factors shall be calculated according to ASTM D 6305. Span ratings after treatment shall be not less than span ratings specified. For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F (76 deg C) shall be not less than span ratings specified.

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

E. Application: Treat all plywood unless otherwise indicated.

2.5 WALL & SOFFIT SHEATHING

1. Span Rating: Not less than 16/0.
2. Nominal Thickness: Not less than 1/2 inch, or as indicated in Drawings.

B. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177/1177M.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. CertainTeed Corporation; GlasRoc.
   b. G-P Gypsum Corporation; Dens-Glass Gold.
   c. National Gypsum Company; Gold Bond e(2)XP.
   d. Temple-Inland Inc.; GreenGlass
   e. United States Gypsum Co.; Securock.
2. Type and Thickness: Regular, thickness as indicated on Drawings.
3. Size: 48 by 96 inches (1219 by 2438 mm) for vertical installation.

2.6 ROOF UNDERLAYMENT

A. Glass-Mat Gypsum Underlayment: ASTM C 1177/1177M.
1. Basis-of-Design Product: Subject to compliance with requirements, provide “Securock” by United States Gypsum Co., or equal.
   a. Underlayment without facing material is required for best performance of fluid applied membrane in green roof system.
2. Type and Thickness: Regular, thickness as indicated on Drawings.
2.7 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.


D. Wood Screws: ASME B18.6.1.

E. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
   1. For steel framing less than 0.0329 inch (0.835 mm) thick, use screws that comply with ASTM C 1002.
   2. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, use screws that comply with ASTM C 954.

2.8 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C 834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
   1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches (50 mm) wide, 10 by 10 or 10 by 20 threads/inch (390 by 390 or 390 by 780 threads/m), of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:
   1. NES NER-272 for power-driven fasteners.
   2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."

D. Use screws unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer's written instructions.
   1. Fasten gypsum sheathing to cold-formed metal framing with screws.
   2. Install boards with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts structural elements.
   3. Install boards with a 1/4-inch (6.4-mm) gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent boards without forcing. Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not less than one stud spacing. Attach boards at perimeter and within field of board to each steel stud.
   1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of boards.

D. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
   1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of boards.

E. Seal sheathing joints according to sheathing manufacturer's written instructions.
   1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
   2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel silicone emulsion sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

3.3 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.
SECTION 06 40 23 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Interior standing and running trim.
   2. Spaced board paneling.
   3. Interior ornamental work.
   4. Wood cabinets.
   5. Solid-surfacing-material countertops.
   6. Closet and utility shelving.
   7. Shop finishing of interior woodwork.
   8. Elm wood from trees on site, provided by Owner. Contractor to provide rough sawing and milling of hardwood to required dimensions, and fabrication of wall paneling and millwork pieces as shown on Drawings.
   9. Phenolic wall and door panels and counters.

B. Related Sections include the following:
   1. Division 06 Section "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.

1.3 DEFINITIONS

A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including cabinet hardware and accessories and finishing materials and processes.

   1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. LEED Submittals:

   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
   2. Certificates for Credit MR 6 Credit MR 7: Chain-of-custody certificates indicating that interior architectural woodwork complies with forest certification requirements. Include
documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.

3. Product Data for Credit IEQ 4.1: For installation adhesives, documentation including printed statement of VOC content.

4. Product Data for Credit IEQ 4.4: For composite wood products and adhesives, documentation indicating that product contains no urea formaldehyde.

C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

1. Show details full size.
2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
3. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers and other items installed in architectural woodwork.

D. Samples for Initial Selection:

1. Shop-applied transparent finishes.
2. Solid-surfacing materials.

E. Samples for Verification:

1. Lumber with or for transparent finish, not less than 50 sq. in., for each species and cut, finished on 1 side and 1 edge.
2. Veneer-faced panel products with or for transparent finish, 8 by 10 inches, for each species and cut. Include at least one face-veneer seam and finish as specified.
3. Solid-surfacing materials, 6 inches square.
4. Exposed cabinet hardware and accessories, one unit for each type and finish.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and fabricator.

B. Product Certificates: For each type of product, signed by product manufacturer.

C. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a certified participant in AWI's Quality Certification Program.

B. Installer Qualifications: Certified participant in AWI's Quality Certification Program.

C. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

1. Provide AWI Quality Certification Program labels and certificates indicating that woodwork, including installation, complies with requirements of grades specified.
D. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Required mockups include, but are not limited to:
      a. Lecture Hall fin wall w/aniline dye boards and surrounding acoustic materials, as directed by Architect.
   2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section “Project Management and Coordination.”

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in “Project Conditions” Article.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
   2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.9 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.
PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.

B. Certified Wood: Interior architectural woodwork shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

C. Wood Species for Opaque Finish: Any closed-grain hardwood.

D. Wood Products: Comply with the following:

1. Recycled Content of Medium-Density Fiberboard and Particleboard: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50% percent.
4. Particleboard: ANSI A208.1, Grade M-2, made with binder containing no urea formaldehyde.
5. Particleboard: Straw-based particleboard complying with requirements in ANSI A208.1, Grade M-2, except for density.

E. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Formica Corporation.
   c. Nevamar Company, LLC; Decorative Products Div.
   d. Wilsonart International; Div. of Premark International, Inc.

2. Type: Standard type, unless Special Purpose type is indicated.
3. Colors and Patterns: As selected by Architect from manufacturer's full range of standard and premium options.

F. Phenolic Panel: Flat panel based on thermosetting resins, homogeneously reinforced with cellulose fibers and manufactured under high pressure and temperature, with a pigmented resin surface.

1. Basis of Design: Subject to requirements, provide 'Athlon' panel as manufactured by Trespa North America, or approved equal.
   a. Panel Core: Type FR fire retardant black core.
   b. Panel Thickness: 3/8” thick for wall panels; ½” thick for door panels and counters.
   c. Finish: Satin sheen.
   d. Color: To be selected by Architect from range of manufacturer's standard and premium colors and finishes.
   e. Number of Colors: Five colors and finishes will be used.
   g. Corner Profile: Sharp corners, no radius.
2.2 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this Article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified.

1. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use the following treatment type:

2. Interior Type A: Low-hygroscopic formulation.
3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking plant certified by testing and inspecting agency.
4. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
5. Kiln-dry materials before and after treatment to levels required for untreated materials.

C. Fire-Retardant Particleboard: Panels complying with the following requirements, made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E 84.

1. For panels 3/4 inch thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi; modulus of elasticity, 300,000 psi; internal bond, 80 psi; and screw-holding capacity on face and edge, 250 and 225 lbf, respectively.
2. For panels 13/16 to 1-1/4 inches thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, 1300 psi; modulus of elasticity, 250,000 psi; linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 250 and 175 lbf, respectively.
3. Product: Subject to compliance with requirements, provide "Duraflake FR" by Weyerhaeuser.

D. Fire-Retardant Fiberboard: Medium-density fiberboard panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E 84.

1. Product: Subject to compliance with requirements, provide "Medite FR" by SierraPine Ltd.; Medite Div.

2.3 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 08 Section "Door Hardware."

B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 170 degrees of opening, self-closing.
C. Cabinet Pulls: The following cabinet pulls are incorporated into the scope of the project and distinguished graphically in the Drawings:
1. Wire Pulls: Back mounted, solid stainless steel, 5 inches long, 2-1/2 inches deep, and 5/16 inch in diameter, satin finish.

D. Catches: Push-in magnetic catches, BHMA A156.9, B03131.

E. Shelf Rests: BHMA A156.9, B04013; metal, two-pin type.

F. Drawer Slides: BHMA A156.9, B05091.
1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-overtravel-extension type; zinc-plated steel ball-bearing slides.

G. Sliding Shutter System: Pocket Door System as manufactured by Hafele, Model 1332 – Accuride.
1. Door thickness: ¾”.
2. Lengths to suit cabinet depths shown on Drawings.

H. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
1. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
2. Satin Stainless Steel: BHMA 630.

I. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

J. Sliding Door Fitting: Pocket Door System as manufactured by Hafele, Model HAWA-Junior 80/B.

K. Sliding Door Fitting: Pocket Door System as manufactured by Hafele, Model HAWA-Lower Guides/Sealing and Buffer Profile.

2.4 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.

B. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.

C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

D. Adhesives, General: Adhesives shall not contain urea formaldehyde.

E. VOC Limits for Installation Adhesives: Installation adhesives shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Wood Glues: 30 g/L.
2. Multipurpose Construction Adhesives: 70 g/L.
3. Contact Adhesive: 250 g/L.
2.5 FABRICATION, GENERAL

A. Interior Woodwork Grade: Unless otherwise indicated, provide Premium-grade interior woodwork complying with referenced quality standard.

B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

C. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

D. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:

E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
   1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.

F. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
   1. Seal edges of openings in countertops with a coat of varnish.

2.6 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

A. Grade: Premium.

B. Wood Species and Cut: Cherry, plain sawn.

   1. Provide split species on trim that faces areas with different wood species, matching each face of woodwork to species and cut of finish wood surfaces in areas finished.

C. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.

2.7 INTERIOR STANDING AND RUNNING TRIM FOR OPAQUE FINISH

A. Grade: Premium.

B. Wood Species: Any closed-grain hardwood.

C. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.
2.8 SPACED BOARD PANELING

A. Grade: Premium.

B. Wood Species and Cut:

1. Plain sawn cherry – locations as indicated on the Drawings.
2. Plain sawn elm – locations as indicated on the Drawings.

C. Built-Up Elm Board Panel: Where the note "Built-Up Elm Board Panel" appears on the Drawings, it refers to individual solid elm boards joined to create a flush-faced solid panel. All methods for concealed joining of solid boards shall be in accordance with AWI Architectural Woodwork Quality Standards and submitted for review as part of the shop drawing review process. [C]

D. Matching of Adjacent Veneer Leaves: Slip match.

E. Veneer Matching within Panel Face: Balance match.

F. Panel-Matching Method: No matching between panels is required. Select and arrange panels for similarity of grain pattern and color between adjacent panels.

G. Fire-Retardant-Treated Board Paneling: Provide panels consisting of wood veneer and fire-retardant particleboard or fire-retardant medium-density fiberboard. Panels shall have flame-spread index of 75 or less and smoke-developed index of 450 or less per ASTM E 84.

2.9 WOOD CABINETS FOR TRANSPARENT FINISH

A. Grade: Premium.

B. AWI Type of Cabinet Construction: Flush overlay.

C. Wood Species and Cut for Exposed Surfaces:

1. Cherry, plain sawn or sliced.
2. Elm, plain sawn or sliced.

D. Semiexposed Surfaces: Provide surface materials indicated below:

1. Surfaces Other Than Drawer Bodies: Same species and cut indicated for exposed surfaces.
2. Drawer Sides and Backs: Solid-hardwood lumber, stained to match species indicated for exposed surfaces.
3. Drawer Bottoms: Hardwood plywood.

2.10 SOLID-SURFACING-MATERIAL COUNTERTOPS

A. Grade: Premium.

B. Solid-Surfacing-Material Thickness: Provide manufacture's standard thickness that will allow Architect to select from manufacture's full range of color, but not less than 3/4 inch. [C]
C. Colors, Patterns, and Finishes: Provide materials and products that result in colors of solid-surfacing material complying with the following requirements:

1. As selected by Architect from manufacturer's full range.

D. Fabricate tops in one piece, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.

1. Fabricate tops with loose backsplashes for field application.

E. Install integral sink bowls in countertops in shop.

F. Drill holes in countertops for plumbing fittings and soap dispensers in shop.

2.11 CLOSET AND UTILITY SHELVING

A. Grade: Premium.

B. Shelf Material: 3/4-inch veneer-faced panel product with veneer edge banding.

C. Wood Species: Plain sliced cherry.

2.12 SHOP FINISHING

A. Grade: Provide finishes of same grades as items to be finished.

B. General: Shop finish transparent-finished interior architectural woodwork at fabrication shop as specified in this Section. Refer to Division 09 painting Sections for finishing opaque-finished architectural woodwork.

C. Finishing Materials: Products shall comply with the testing and product requirements of the California Department of Health Services "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Shop Priming: Shop apply the prime coat including backpriming, if any, for items specified to be field finished. Refer to Division 09 painting Sections for material and application requirements.

E. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.

1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces.

F. Transparent Finish:

1. Grade: Premium.
2. AWI Finish System for clear finish: Acrylic Lacquer.
3. AWI Finish System for stained finish: Aniline Dye with Acrylic Lacquer.
5. Stain Colors: One color will be used.
6. Wash Coat for Stained Finish: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
7. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D 523.
PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.

B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.

B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.

C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.

D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.

F. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

G. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 96 inches long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.

1. Fill gaps, if any, between top of base and wall with plastic wood filler, sand smooth, and finish same as wood base if finished.
2. Install wall railings on indicated metal brackets securely fastened to wall framing.
3. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches.

H. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
2. Maintain veneer sequence matching of cabinets with transparent finish.
3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.
I. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.

1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
2. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
3. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c. and to walls with adhesive.
4. Calk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."

J. Phenolic Panels: Install as indicated on Drawings. All fasteners to be concealed.

K. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

L. Refer to Division 09 Sections for final finishing of installed architectural woodwork not indicated to be shop finished.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

3.4 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 06 40 23
SECTION 07 11 00 – SHEET MEMBRANE WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.2 SECTION INCLUDES

A. Self-adhesive elastomeric sheet membrane waterproofing.

1.3 RELATED SECTIONS

A. Section 02223 - Backfilling.
B. Section 03300 – Cast-in-Place Concrete.
C. Section 07900 – Joint Sealers.

1.4 REFERENCES

C. ANSI/ASTM D 746 – Brittleness Temperature of Plastics and Elastomers by Impact.
D. ASTM D 1004 – Initial Tear Resistance of Plastic Film and Sheeting.

1.5 SUBMITTALS

A. Submit Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.
B. Product Data: Provide data for surface conditioner, flexible flashings, joint cover sheet, and joint and crack sealants, with temperature range for application of waterproofing membrane.
C. Manufacturer’s Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
D. Manufacturer’s Certificate: Certify that Products meet or exceed specified requirements.

1.6 QUALITY ASSURANCE
A. Perform work in accordance with NRCA Waterproofing Manual.

1.7 QUALIFICATIONS

A. Membrane Manufacturer: Company specializing in waterproofing sheet membranes with 3 years of experience.

B. Applicator: Company specializing in performing the work of this section approved by manufacturer.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures above 40º F for 24 hours before and during application and until liquid or mastic accessories have cured.

1.9 WARRANTY

A. Provide 5-year warranty.

B. Warranty: Include coverage for waterproofing failing to resist penetration of water, except where such failures are the result of structural failures of building. Hairline cracking of concrete due to temperature change or shrinkage is not considered a structural failure.

C. For warranty repair work, be responsible for moving and replacing materials concealing waterproofing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Polyken – Product 660.

B. Or equal approved by the Engineer/Owner’s Representative.

2.2 MEMBRANE MATERIALS

A. Plastic Membrane: Composite sheet of polyethylene backing and butyl rubber with self-adhering adhesive and cold temperature flexibility and adhesion.

B. Membrane 60 mils thick; 36-inch-wide roll, conforming to the following criteria:

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength</td>
<td>ASTM D 412</td>
<td>500 min.</td>
</tr>
<tr>
<td>Elongation</td>
<td>ASTM D 412</td>
<td>300 min.</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>ASTM D5710</td>
<td>.12% by weight</td>
</tr>
<tr>
<td>Moisture Vapor</td>
<td>ASTM E 96</td>
<td>0.8 perms</td>
</tr>
</tbody>
</table>
C. Seaming Materials: As recommended by membrane manufacturer.
D. Flexible Flashings: As recommended by membrane manufacturer.

2.3 ADHESIVE MATERIALS
A. Surface Conditioner: As recommended by membrane manufacturer.
B. Adhesives: As recommended by membrane manufacturer.
C. Thinner and Cleaner: As recommended by adhesive manufacturer, compatible with sheet membrane.

2.4 ATTACHMENT MATERIALS
A. Reglet Strip Devices: See Section 03300: Cast-in-Place Concrete.

2.5 ACCESSORIES
A. Sealant: As recommended by membrane manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Verify substrate surfaces are durable; free or matter detrimental to adhesion or application of waterproofing system.
B. Verify items which penetrate surfaces to receive waterproofing are securely installed.

3.2 PREPARATION
A. Protect adjacent surfaces not designated to receive waterproofing.
B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer’s instructions. Vacuum substrate clean.
C. Do not apply waterproofing to surfaces unacceptable to manufacturer or applicator.
D. Seal cracks and joints with sealant materials using depth to widen ratio as recommended by sealant manufacturer.
E. Apply surface conditioner at a rate recommended by manufacturer. Protect conditioner from rain or frost until dry.

3.3 INSTALLATION
A. Install membrane waterproofing in accordance with manufacturer’s instructions.
B. Roll out membrane. Minimize wrinkles and bubbles.
C. Remove release paper layer. Roll out on substrate with a mechanical roller to encourage full contact bond.
D. Lap sides and ends in accordance with membrane manufacturer’s instructions.

E. Overlap edges and ends and seal with contact adhesive, minimum 6 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.

F. Reinforce membrane with multiple thicknesses of membrane material over joints, whether joints are static or moving.

G. Weather lap joints on sloped substrate in direction of drainage. Seal joints and seams.

H. Install flexible flashings. Seal watertight to membrane.

I. Seal membrane and flashings to adjoining surfaces.

J. Extend membrane minimum of 6 inches onto vertical surfaces.

K. Seal items penetrating membrane and install counter flashing membrane material.

3.4 PROTECTION OF FINISHED WORK

A. Protect finished work.

B. Do not permit traffic over unprotected or uncovered membrane.

END OF SECTION 07 11 00
SECTION 07 13 26 - SELF-ADHERING SHEET WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Modified bituminous sheet waterproofing.
      2. Insulation drainage panels for vertical wall applications.

1.3 PREINSTALLATION MEETINGS
   A. Preinstallation Conference: Conduct conference at Project site.
      1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
      2. Include manufacturer’s written instructions for evaluating, preparing, and treating substrate.
   B. LEED Submittals:
      1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
   C. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
   D. Samples: For each exposed product and for each color and texture specified, including the following products:
      1. 8-by-8-inch (200-by-200-mm) square of waterproofing and flashing sheet.

1.5 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For Installer.
   B. Field quality-control reports.
   C. Sample Warranties: For special warranties.
1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals and to set quality standards for installation.
   1. Build for each typical waterproofing installation including accessories to demonstrate surface preparation, crack and joint treatment, corner treatment, and protection.
      a. Size: 100 sq. ft. in area.
      b. Description: Each type of wall installation.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.
   1. Do not apply waterproofing in snow, rain, fog, or mist.

B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer's standard materials-only warranty in which manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

B. Installer's Special Warranty: Specified form, signed by Installer, covering Work of this Section, for warranty period of two years.
   1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, lawn, landscape features and terrace paving.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Source Limitations for Waterproofing System: Obtain waterproofing materials from single source from single manufacturer.

2.2 MODIFIED BITUMINOUS SHEET WATERPROOFING

A. Modified Bituminous Sheet: Minimum 60-mil (1.5-mm) nominal thickness, self-adhering sheet consisting of 56 mils (1.4 mm) of rubberized asphalt laminated on one side to a 4-mil- (0.10-mm-) thick, polyethylene-film reinforcement, and with release liner on adhesive side; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   2. Physical Properties:
a. Tensile Strength, Membrane: 325 psi (2240 kPa) minimum; ASTM D 412, Die C, modified.
b. Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
c. Low-Temperature Flexibility: Pass at minus 20 deg F (minus 29 deg C); ASTM D 1970.
d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch (3-mm) movement; ASTM C 836.
e. Puncture Resistance: 40 lbf (180 N) minimum; ASTM E 154.
f. Water Absorption: 0.2 percent weight-gain maximum after 48-hour immersion at 70 deg F (21 deg C); ASTM D 570.
g. Water Vapor Permeance: 0.05 perms (2.9 ng/Pa x s x sq. m) maximum; ASTM E 96/E 96M, Water Method.
h. Hydrostatic-Head Resistance: 231 feet (70 m) minimum; ASTM D 5385.


2.3 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
   1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.

B. Primer: Liquid waterborne primer recommended for substrate by sheet-waterproofing material manufacturer.

C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by sheet-waterproofing material manufacturer.

D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.

E. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating.

F. Metal Termination Bars: Aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick, predrilled at 9-inch (229-mm) centers.

2.4 INSULATION DRAINAGE PANELS

A. This product intended for vertical application against below grade walls.

B. Geotextile-Faced, Wall-Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi (276-kPa) minimum compressive strength; fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with nonwoven geotextile filter fabric.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Owens Corning Insulating Systems LLC; Insul-Drain.
      b. T. Clear Corporation, a subsidiary of Fin Pan Inc.; Thermadry 1250.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the waterproofing.
1. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
3. Verify that compacted subgrade is dry, smooth, sound, and ready to receive waterproofing sheet.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.
1. Install sheet strips of width according to manufacturer's written instructions and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch (1.6 mm).
F. Bridge and cover isolation joints, expansion joints and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips of widths according to manufacturer's written instructions.
1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.
G. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.
1. Install membrane strips centered over vertical inside corners. Install 3/4-inch (19-mm) fillets of liquid membrane on horizontal inside corners and as follows:
a. At footing-to-wall intersections, extend liquid membrane in each direction from corner or install membrane strip centered over corner.
H. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to ASTM D 6135.

3.3 MODIFIED BITUMINOUS SHEET-WATERPROOFING APPLICATION

A. Install modified bituminous sheets according to waterproofing manufacturer's written instructions and recommendations in ASTM D 6135.
B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.
C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- (64-mm-) minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure watertight installation.
1. When ambient and substrate temperatures range between 25 and 40 deg F (minus 4 and plus 5 deg C), install self-adhering, modified bituminous sheets produced for low-temperature
application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F (16 deg C).

D. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.

E. Seal edges of sheet-waterproofing terminations with mastic.

F. Install sheet-waterproofing and auxiliary materials to tie into adjacent waterproofing.

G. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches (150 mm) beyond repaired areas in all directions.

3.4 INSULATION AND INSULATION DRAINAGE-PANEL INSTALLATION

A. Install insulation drainage panels over waterproofed surfaces; cut and fit to within 3/4 inch (19 mm) of projections and penetrations.

B. Ensure that drainage channels are aligned and free of obstructions.

C. On vertical surfaces, set insulation drainage panels in adhesive or tape applied according to manufacturer's written instructions.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish daily reports to Architect.

B. Prepare test and inspection reports.

3.6 PROTECTION, REPAIR, AND CLEANING

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.7 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:

1. Aluminum
2. Plastic Materials and Gaskets
3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 07 13 26
SECTION 07 21 00 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Foam-plastic board insulation.
   2. Glass-fiber blanket insulation.
   4. Spray polyurethane foam insulation.

B. Related Sections:
   1. Division 04 Section "Unit Masonry" for insulation installed in cavity walls and masonry cells.
   2. Division 07 Section "Self-Adhering Sheet Waterproofing" for insulation panels and insulated drainage panels installed with waterproofing.
   3. Division 07 Sections "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing" and "Garden Roof System" for insulation specified as part of roofing construction.
   4. Division 07 Section "Fire-Resistive Joint Systems" for insulation installed as part of a perimeter fire-resistive joint system.
   5. Division 09 Section "Gypsum Board" for sound attenuation insulation in gypsum board assemblies.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

B. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:
1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Dow Chemical Company (The).
      b. Owens Corning.
   2. Type IV, 25 psi (173 kPa).
   3. Provide boards with thermal resistance indicated:
      a. 5.6 deg F x h x sq. ft./Btu x in. at 75 deg F per inch of thickness
   4. Thickness: 2” unless otherwise noted.

B. Foil-Faced and Unfaced, Polyisocyanurate Board Insulation: ASTM C 1289, Type I, Class 1 or Class 2, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. Dow Chemical Company (The).
      c. Rmax, Inc.
   2. Where polyisocyanurate board insulation is indicated in horizontal applications, provide total thickness indicated in two layers with staggered joints. Provide foil faced insulation at layer with foil facing the conditioned side of the building envelope. Install the unfaced layer on the unconditioned side of the building envelope.
   3. Provide boards with thermal resistances indicated:
      a. 6.5 deg F x h x sq. ft./Btu x in. at 75 deg F per inch of thickness

C. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

2.2 GLASS-FIBER BLANKET INSULATION

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. CertainTeed Corporation.
   2. Guardian Building Products, Inc.
5. Owens Corning.

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.

C. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

D. Reinforced-Foil-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (reflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

E. Sustainability Requirements: Provide glass-fiber blanket insulation as follows:
   1. Free of Formaldehyde: Insulation manufactured with 100 percent acrylic binders and no formaldehyde.
   2. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.

2.3 MINERAL-WOOL BLANKET INSULATION

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Fibrex Insulations Inc.
   2. Owens Corning.
   3. Roxul Inc.
   4. Thermafiber.

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.

C. Unfaced, Mineral-Wool Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

2.4 SPRAY POLYURETHANE FOAM INSULATION

A. Closed-Cell Polyurethane Foam Insulation: ASTM C 1029, Type II, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
   1. Basis of Design Product: Subject to compliance with requirements, provide Tiger Foam Insulation, A Commercial Thermal Solution Company, 800.664.0063, or approved equal
      a. Two-part fire retardant semi-rigid closed-cell foam.
      b. ASTM E-84 Class 1 approval.
      c. Flame Spread = 25.
      d. Smoke Developed = 200.
      e. ODP (Ozone-Depletion Potential): Contains non-ozone-depleting, non-flammable HRC propellant.
      f. Not resistant to UV light and must be painted, coated or covered if exposed to direct sunlight after application.
      g. Density: 1.75 lbs/sq ft.
      h. R-Value: 6.2-7.4 per inch.
2.5 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.
   1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.762 mm) thick by 2 inches (50 mm) square.
   2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation indicated.

B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.
   1. Angle: Formed from 0.030-inch- (0.762-mm-) thick, perforated, galvanized carbon-steel sheet with each leg 2 inches (50 mm) square.
   2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation indicated.

C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches (38 mm) square or in diameter.
   1. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap.

D. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF BELOW-GRADE INSULATION

1. See Division 07 Section "Self-Adhering Sheet Waterproofing" for insulation panels and insulated drainage panels installed with waterproofing.

3.4 INSTALLATION OF CAVITY-WALL INSULATION

1. See Division 04 Section "Unit Masonry" for insulation installed in cavity walls and masonry cells.
3.5 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, use mechanical anchorage to provide permanent placement and support of units.

B. Glass-Fiber or Mineral-Wool Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
   1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
   2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
   3. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
   4. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
   5. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
      a. Exterior Walls: Set units with facing placed toward interior of construction.

C. Foam-Plastic Board Insulation: Seal joints between units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal.

D. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
   1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.6 INSTALLATION OF INSULATION IN CEILINGS FOR SOUND ATTENUATION

A. Where mineral-wool blankets are indicated for sound attenuation above ceilings, install blanket insulation over entire ceiling area in thicknesses indicated. Extend insulation 48 inches (1219 mm) up either side of partitions.

3.7 INSTALLATION OF SPINDLE ATTACHED INSULATION

A. Install board insulation by adhesively attached, spindle-type insulation anchors as follows:
   1. Fasten insulation anchors to substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
   2. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
   3. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

3.8 INSTALLATION OF CURTAIN-WALL INSULATION

A. Install board insulation in curtain-wall construction where indicated on Drawings according to curtain-wall manufacturer's written instructions.
   1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold
insulation securely in place without touching spandrel glass. Maintain cavity width of
dimension indicated between insulation and glass.
2. Install insulation where it contacts perimeter fire-containment system to prevent insulation
from bowing under pressure from perimeter fire-containment system.

3.9 PROTECTION

A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures,
physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is
subject to abuse and cannot be concealed and protected by permanent construction immediately
after installation.

3.10 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials
while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in
designated areas for reuse or recycling. If recycling options are available locally or through
manufacturer, recycle as a minimum, the following materials:
1. Aluminum
2. Plastic Materials and Gaskets
3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 07 21 00
SECTION 07 27 26 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes fluid-applied, vapor-retarding membrane air barriers.

B. Related Requirements:
   1. Division 06 Section "Sheathing" for wall sheathings and wall sheathing joint-and-penetration treatments.
   2. Division 07 Section “Sheet Metal Flashing and Trim” for metal flashings associated with the membrane air barrier.

1.3 DEFINITIONS

A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.

B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.

C. Air-Barrier Assembly: The collection of air-barrier materials and accessory materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include manufacturer’s written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of products.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.2: For air-barrier products, documentation including printed statement of VOC content.

C. Shop Drawings: For air-barrier assemblies.
   1. Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
   2. Include details of interfaces with other materials that form part of air barrier.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.
B. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier.

C. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
   1. Installer shall be licensed by ABAA according to ABAA’s Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.

B. Mockups: Build mockups to set quality standards for materials and execution and for preconstruction testing.
   1. Build integrated mockups of exterior wall assembly as shown on Drawings, incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
      a. Coordinate construction of mockups to permit inspection by Owner's testing agency of air barrier before external insulation and cladding are installed.
      b. Include junction with roofing membrane, building corner condition, and foundation wall intersection.
      c. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Remove and replace liquid materials that cannot be applied within their stated shelf life.

B. Protect stored materials from direct sunlight.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air-barrier manufacturer.
   1. Protect substrates from environmental conditions that affect air-barrier performance.
   2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.

B. VOC Content: 75 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and complying with VOC content limits of authorities having jurisdiction.
2.2 PERFORMANCE REQUIREMENTS

A. General: Air barrier shall be capable of performing as a continuous vapor-retarding air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

B. Air-Barrier Assembly Air Leakage: Maximum 0.0008 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. (0.004 L/s x sq. m of surface area at 75 Pa), when tested according to ASTM E 2357.

2.3 VAPOR-RETARDING MEMBRANE AIR BARRIER


1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Synthetic Polymer Membrane:

2. Physical and Performance Properties:
   a. Air Permeance: Maximum 0.0002 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. (0.001 L/s x sq. m of surface area at 75-Pa)
   b. Vapor Permeance: Maximum 0.08 perm (4.6 ng/Pa x s x sq. m)
   c. Ultimate Elongation: Minimum 500 percent; ASTM D 412, Die C.

2.4 ACCESSORY MATERIALS

A. General: Accessory materials recommended by air-barrier manufacturer to produce a complete air-barrier assembly and compatible with primary air-barrier material.

B. Transition Membrane: Vapor retarding, 40 mils (1.0 mm) thick, smooth surfaced, self-adhering; consisting of 36 mils (0.9 mm) of rubberized asphalt laminated to a 4-mil- (0.1-mm-) thick polyethylene film with release liner backing.

C. Flexible Membrane Wall Flashing: Vapor retarding, 40 mils (1.0 mm) thick, smooth surfaced, self-adhering; consisting of 32 mils (0.8 mm) of rubberized asphalt laminated to a 2-mil- (0.2-mm-) thick polyethylene film with release liner backing.

D. Joint Reinforcing Strip: Air-barrier manufacturer's glass-fiber-mesh tape.

E. Substrate-Patching Membrane: Manufacturer's standard trowel-grade substrate filler.

F. Adhesive and Tape: Air-barrier manufacturer's standard adhesive and pressure-sensitive adhesive tape.

G. Sprayed Polyurethane Foam Sealant: One- or two-component, foamed-in-place, polyurethane foam sealant, 1.5- to 2.0-lb/cu. ft (24- to 32-kg/cu. m) density; flame-spread index of 25 or less according to ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.

H. Joint Sealant: ASTM C 920, single-component, neutral-curing silicone; Class 100/50 (low modulus), Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Division 07 Section “Joint Sealants.”

I. Termination Mastic: Air-barrier manufacturer's standard cold fluid-applied elastomeric liquid; trowel grade.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
   1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
   2. Verify that concrete has cured and aged for minimum time period recommended by air-barrier manufacturer.
   3. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
   4. Verify that masonry joints are flush and completely filled with mortar.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean, prepare, treat, and seal substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air-barrier application.

B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.

E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

3.3 JOINT TREATMENT

A. Concrete and Masonry: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 1193 and air-barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D 4258 before coating surfaces.

B. Gypsum Sheathing: Fill joints greater than 1/4 inch (6 mm) with sealant according to ASTM C 1193 and air-barrier manufacturer's written instructions. Apply first layer of fluid air-barrier material at joints. Tape joints with joint reinforcing strip after first layer is dry. Apply a second layer of fluid air-barrier material over joint reinforcing strip.

3.4 TRANSITION STRIP INSTALLATION

A. General: Install strips, transition strips, and accessory materials according to air-barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.
1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.

2. Install modified bituminous strip on roofing membrane or base flashing so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate.

B. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

C. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.

D. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

E. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply modified bituminous transition strip so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames with not less than 1 inch (25 mm) of full contact.

1. Modified Bituminous Transition Strip: Roll firmly to enhance adhesion.

F. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.

G. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.

H. Seal top of through-wall flashings to air barrier with an additional 6-inch- (150-mm-) wide, modified bituminous strip.

I. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

J. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches (150 mm) beyond repaired areas in strip direction.

3.5 FLUID AIR-BARRIER MEMBRANE INSTALLATION

A. General: Apply fluid air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier according to air-barrier manufacturer's written instructions. Apply fluid air-barrier material within manufacturer's recommended application temperature ranges.

B. Membrane Air Barriers: Apply a continuous unbroken air-barrier membrane to substrates according to the following thickness. Apply air-barrier membrane in full contact around protrusions such as masonry ties.

1. Total dry film thickness as recommended in writing by manufacturer to meet performance requirements, but not less than 60-mil (1.5-mm) dry film thickness.

2. Spray using cross-hatching technique (alternating horizontal and vertical passes) to ensure even thickness and coverage.

3. When spraying use high pressure, multi-component, airless spray equipment approved by material manufacturer.

4. Carry membrane into any openings a minimum of 50 mm (2 in).

5. Seal all brick ties and other penetrations as work progresses.
C. Apply strip and transition strip over cured air-barrier material overlapping 3 inches (75 mm) onto each surface according to air-barrier manufacturer's written instructions.

D. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.

E. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

F. Do not allow the rubberized asphalt surface of the flashing membrane to come in contact with polysulfide sealants, creosote, uncured coal tar products or EPDM.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
   1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
   2. Continuous structural support of air-barrier system has been provided.
   3. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
   4. Site conditions for application temperature and dryness of substrates have been maintained.
   5. Maximum exposure time of materials to UV deterioration has not been exceeded.
   6. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
   7. Termination mastic has been applied on cut edges.
   8. Strips and transition strips have been firmly adhered to substrate.
   9. Compatible materials have been used.
   10. Transitions at changes in direction and structural support at gaps have been provided.
   11. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
   12. All penetrations have been sealed.

C. Tests: As determined by Owner's testing agency from among the following tests:
   1. Adhesion Testing: Air-barrier assemblies will be tested for minimum air-barrier adhesion of 30 lbf/sq. in. (207 kPa) according to ASTM D 4541 for each 600 sq. ft. (56 sq. m) of installed air barrier or part thereof.

D. Air barriers will be considered defective if they do not pass tests and inspections.
   1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
   2. Remove and replace deficient air-barrier components for retesting as specified above.

E. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

3.7 CLEANING AND PROTECTION

A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
   1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. If exposed to these conditions for more than 60 days, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed membrane according to air-barrier manufacturer's written instructions.
   2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.
B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended by manufacturer of affected construction.

C. Remove masking materials after installation.

3.8 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 07 27 26
SECTION 07 31 26 - SLATE SHINGLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Slate shingles.
   2. Underlayment.
   3. Copper flashing and sheet metal work.
   4. Copper screen for eave venting.
   5. Ridge vent product.
   6. Snow guards.

B. Related Sections:
   1. Division 06 Section "Sheathing" for roof sheathing.
   2. Division 07 Section “Sheet Metal Flashing & Trim” for flashing and trim not specified here.
   3. Division 07 Section “Joint Sealants” for joint sealants used in conjunction with slate roofing.

1.3 DEFINITIONS

A. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection: Of each color, size, texture, and shape.
   1. Include similar Samples of trim and accessories involving color selection.

C. Samples for Verification: For the following products, of sizes indicated, to verify color selected:
   1. Slate Shingle: 6 shingles illustrating the full range of colors in the blend.
   2. Underlayment.
   3. Ridge Vent: 12-inch Sample.
   5. Fasteners: Three fasteners of each type, length, and finish.

1.5 INFORMATIONAL SUBMITTALS

A. Material Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each slate variety.

B. Warranty: Sample of special warranty.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Slate Shingles: 100 sq. ft. of each type and color, in unbroken bundles.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain each color of slate shingle from single quarry capable of producing slate of consistent quality in appearance and physical properties.

B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Build mockups for slate shingles including related roofing materials, including flashings and snow guards.
   a. Size: 48 inches long by 48 inches wide.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Preinstallation Conference: Conduct conference at Project site.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store underlayment rolls on end, on pallets or other raised surfaces. Do not double stack rolls.
1. Handle, store, and place roofing materials in a manner to avoid significant or permanent damage to roof deck or structural supporting members.

B. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Proceed with installation of self-adhering sheet underlayment only within the range of ambient and substrate temperatures recommended by manufacturer.

1.10 WARRANTY

A. Special Warranty: Standard form in which roofing Installer agrees to repair or replace slate roofing that fails in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SLATE SHINGLES

A. Slate Shingles: ASTM C 406, Grade S1; hard, dense, and sound; chamfered edges, with nail holes machine punched or drilled and countersunk. No broken or cracked slates, no broken exposed corners, and no broken corners on covered ends that could sacrifice nailing strength or laying of a watertight roof.
2. Size: 18 inches long by 12 inches wide.
3. Nail Holes: Two per shingle, placed 1-1/4" to 1-1/2" from edge, and exposure + 4-1/2" from bottom.
5. Color: Black.

B. Starter Slate: Slate shingles with chamfered nail holes front-side punched.
1. Length: Exposure of slate shingle plus head lap.
2. Width: to match field slates.

C. Physical Requirements:
1. Slates with a strong grain must be produced “on the grain”, that is, the direction of the grain of the stone must be parallel to the long dimension of the shingle. Slates shall be randomly selected from each shipment and tested for grain direction to ensure proper fabrication.
2. Slates with broken corners on the exposed ends shall not be installed when either the base or leg of the right triangular piece broken off is greater than 1 ½ inches. Slates with broken corners are acceptable for cutting stock.
3. The curvature of shingles shall not exceed 1/8 inch in 12 inches. Curved slates shall be trimmed and holed to permit them to be laid with the convex side facing up.
4. “Knots” and “knurls” are rounded defects that affect the smoothness of split. They are acceptable on the exposed portion of the top face but on other parts will prevent close contact of shingles. Shingles having knots or knurls on the covered portions projecting in excess of 1/16 inch shall not be used if they prevent proper fit and contact.
5. Slates shall be free from ribbons.
6. Face dimensions shall not differ from those specified by more than 1/8 inch.

2.2 UNDERLAYMENT MATERIALS
A. Felt Underlayment: Water repellant, breather type cellulose/glass fiber composite roofing underlayment.
1. 30# “Leatherback” as manufactured by GAF Materials Corporation, or a comparable product.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Grace Ice & Water Shield, as manufactured by Grace Construction Products, a division of W.R.Grace & Co., or comparable product.

2.3 SNOW GUARDS
A. Snow-Guard Pads: Fabricated cast-bronze units, designed to be installed without penetrating slate shingles, and complete with predrilled holes or hooks for anchoring.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Model #200S-NA “Snow Spikes” as manufactured by Bronze Guard, a division of M. J. Mullane Company, Inc., Hudson, MA., or a comparable product.

2.4 ACCESSORIES
A. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.
B. Slating Nails: ASTM F 1667, stainless-steel, ribbed shanked, wire nails; 0.135-inch minimum thickness; sharp pointed; with 3/8-inch- minimum diameter flat head; of sufficient length to penetrate a minimum of 3/4 inch into sheathing without penetrating through sheathing.
C. Felt Underlayment Nails: Stainless-steel wire nails with low-profile capped heads or disc caps, 1-inch minimum diameter.

2.5 METAL FLASHING AND TRIM
A. General: Comply with requirements in Division 07 Section “Sheet Metal Flashing and Trim.”
2. Flashing thickness: Minimum 16 oz.
B. Fabricate sheet metal flashing and trim to comply with recommendations that apply to design, dimensions, metal, and other characteristics of the item in SMACNA's "Architectural Sheet Metal Manual" and Revere's "Copper and Common Sense."
   1. Apron Flashings: Fabricate with lower flange extending a minimum of 4 inches over and 4 inches beyond each side of downslope slate shingles and 6 inches up the vertical surface.
   2. Step Flashings: Fabricate with a head lap of 3 inches and a minimum extension of 4 inches both horizontally and vertically.
   3. Cricket Flashings: Fabricate with concealed flange extending a minimum of 18 inches beneath upslope slate shingles and 6 inches beyond each side of chimney or skylight and 6 inches above the roof plane.
   4. Hip Flashings: Fabricate to length of slate shingle and to extend 3 inches beyond joint of hip shingle with adjoining roof shingle.
   5. Open-Valley Flashings: Fabricate in lengths not exceeding 10 feet with 1-inch-high, inverted-V profile at center of valley and equal flange widths of 12 inches.
   6. Closed-Valley Flashings: Fabricate in lengths not exceeding 10 feet and equal flange widths of 12 inches.
   7. Drip Edges: Fabricate in lengths not exceeding 10 feet with 2-inch roof-deck flange and 1-1/2-inch fascia flange with 3/8-inch drip at lower edge.

C. Vent-Pipe Flashings: ASTM B 749, Type L51121, at least 1/16 inch thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof and extending at least 4 inches from pipe onto roof.

   1. Model: Vented.
   2. Material: Vent to be slate covered and manufactured from 20 oz zinc/tin coated copper.
   3. Provide end caps manufactured from 20 oz zinc/tin coated copper.
   4. Provide ventilating mesh product as manufactured by Castle Metal Products along entire length of ridge vent.
   5. Provide ventilating base approved for use by Top Slate manufacturer; Ventilating base shall be continuous low profile and resistant to compression, providing a net free area of 18 sq in / lineal foot of ridge.
   6. Install per manufacturer's instructions.
   7. Slates installed over ridge vent to be twice as long as typical roofing slates.
   8. Color of ridge slates to match typical roofing slates.

E. Soffit Vent: Copper insect screen.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking or metal clips and that installation is within flatness tolerances.
   2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored and that provision has been made for flashings and penetrations through roofing.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

A. General: Comply with underlayment manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
B. Single-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches over underlying course. Lap ends a minimum of 4 inches. Stagger end laps between succeeding courses at least 72 inches. Fasten with felt underlayment nails.
   1. Install felt underlayment on roof deck not covered by self-adhering sheet underlayment. Lap sides of felt over self-adhering sheet underlayment not less than 3 inches in direction to shed water. Lap ends of felt not less than 6 inches over self-adhering sheet underlayment.

C. Self-Adhering Sheet Underlayment: Install, wrinkle free, on roof deck. Comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install at locations indicated below and on Drawings, lapped in direction to shed water. Lap sides not less than 3-1/2 inches. Lap ends not less than 6 inches, staggered 24 inches between courses. Roll laps with roller. Cover underlayment within seven days.
   1. Eaves: Extend from edges of eaves 36 inches beyond interior face of exterior wall.
   2. Rakes: Extend from edges of rakes 36 inches beyond interior face of exterior wall.
   3. Hips: Extend 18 inches on each side.
   4. Ridges: Extend 36 inches on each side without obstructing continuous ridge vent slot.
   5. Sidewalls: Extend 18 inches beyond sidewalls and return vertically against sidewalls not less than 4 inches.
   6. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend 18 inches beyond penetrating elements and return vertically against penetrating elements not less than 4 inches.
   7. Roof-Slope Transitions: Extend 18 inches on each roof slope.

3.3 METAL FLASHING INSTALLATION

A. General: Install metal flashings and other sheet metal to comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim."
   1. Install metal flashings according to recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."

B. Apron Flashings: Extend lower flange over and beyond each side of downslope slate shingles and up the vertical surface.

C. Step Flashings: Install with a head lap of 3 inches and extend both horizontally and vertically. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying slate shingle. Fasten to roof deck only.

D. Cricket Flashings: Install against the roof-penetrating element, extending concealed flange beneath upslope slate shingles and beyond each side.

E. Hip Flashings: Install centrally over hip with lower edge of flashing concealed by butt of overlying slate shingle. Fasten to roof deck.

F. Rake Drip Edges: Install over underlayment and fasten to roof deck.

G. Eave Drip Edges: Install beneath underlayment and fasten to roof deck.

H. Pipe Flashings: Form flashing around pipe penetrations and slate shingles. Fasten and seal to slate shingles.

3.4 SLATE-SHINGLE INSTALLATION

A. General: Beginning at eaves, install slate shingles according to manufacturer's written instructions and to details and recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
   1. Install preformed copper drip edge with built-in inverted 'V' groove cant at eave edges.
   2. Install shingle starter course chamfered face down.
B. Install first and succeeding shingle courses with chamfered face up. Install full-width first course at rake edge.
   1. Offset joints of uniform-width slate shingles by half the shingle width in succeeding courses.

C. Maintain a 3-inch- minimum head lap between succeeding shingle courses.

D. Each course shall break joints laterally by a minimum of 3”, if possible, with the underlying or overlying course.

E. Maintain uniform 7 ½ inch exposure of shingle courses.

F. Extend shingle starter course and first course over fasciae at eaves as indicated on Drawings.

G. Cut and fit slate neatly around roof vents, pipes, ventilators, and other projections through roof.

H. Hang slate with two slating nails for each shingle with nail heads lightly touching slate. Do not drive nails home drawing slates downward or leave nail head protruding enough to interfere with overlapping shingle above.
   1. For vented ridge, terminate slate shingles leaving uniform air space on each side of ridge apex.
   2. Install vented ridge cap as shown in Drawings.

I. Hips: Install and anchor slate hips in mitered configuration.
   1. Form hips by butting the cut and fitted roof slates at the hip, maintaining regular coursing. If required, vary the width of the slates in the course so that there are no small triangles of slate at the hip, without the capability of concealing nailing.

3.5 SNOW-GUARD INSTALLATION

A. Snow-Guard Pads: Install snow-guards in pattern indicated on Drawings.

B. Build into field of roofing slates as the roofing installation progresses, nailing into roof deck.

C. Remove and replace damaged or broken slate shingles.

D. Remove excess slate and debris from Project site.

3.6 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 07 31 26
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Horizontal hot fluid applied rubberized asphalt membrane.
2. Roofing components.
3. Rigid insulation.
4. Washed smooth river stone.

B. Related Sections include the following:

1. Division 6 Section “Rough Carpentry” for blocking and curbing.
2. Division 7 Section “Sheet Metal Flashing and Trim” for metal roof penetration flashings, flashings, and counterflashings.
3. Division 7 Section “Sheathing” for gypsum fiber sheathing under garden roof systems.
4. Division 7 Section “Joint Sealants”.
5. Division 15 Section “Plumbing Specialties” for roof drains.
6. Division 32 Section “Roof Garden Landscaping.”

1.3 DEFINITIONS

A. Green Roof: An area of planting/landscaping, built up on a waterproofed substrate at any level that is separated from the natural ground by a man-made structure.

B. Extensive Green Roof: Low to no maintenance landscaping consisting of shallow soil depths (6 inches or less) with plant varieties restricted to primarily mosses, herbs and succulents capable of withstandning harsh growing conditions.

1.4 REFERENCES

A. American Society for Testing and materials (ASTM):

1. ASTM D 36: Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus.)
2. ASTM D 92: Test Method for Flash and Fire Points by Cleveland Open Cup.

1.5 PERFORMANCE REQUIREMENTS

A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

1.6 SYSTEM DESCRIPTION

A. Garden Roof System to be installed over:
   1. Concrete substrate.
   2. Metal deck with glass mat sheathing.

B. Garden Roof System to consist of:
   1. Fluid-applied hot rubberized membrane waterproofing.
   2. Flashings.
   3. Rigid insulation.
   5. Roof garden soil mix and landscaping as specified in Section 32 95 00 Roof Garden Landscaping.

1.7 SUBMITTALS

A. Product Data: For each type of product indicated. Include descriptive published data indicating characteristics and limitations. Include standard details and system components.

B. Shop Drawings: Plan layout, vertical sections through system, and details at critical terminations of garden roof system with adjacent construction. Include additional details not covered by manufacturer’s instructions and Product Data.

C. Samples for Verification:
   1. Garden roof system components, including water retention/drainage panel and other components for retaining and managing water system.
   2. Washed smooth river stone: Submit range of available colors for selection by Architect.
   3. Growing Media: 1-pint (0.5-liter) volume of each growing medium, in sealed plastic bags labeled with content and source. Each Sample shall be typical of the lots of growing media to be furnished. Provide an accurate representation of texture and composition.
   4. Moisture-Retention Mat: 12 by 12 inches (300 by 300 mm).
   5. Molded-Sheet Drainage Panels: 12 by 12 inches (300 by 300 mm).
   6. Protection Fabric: 12 by 12 inches (300 by 300 mm).
   7. Drainage Gravel: 1-pint (0.5-liter) Insert quantity volume in sealed plastic bags labeled with content and source.
   8. Root Barrier: 12 by 12 inches (300 by 300 mm).
   9. Separation Geotextile: 12 by 12 inches (300 by 300 mm).
   10. Access Boxes: One in each size and color required.
   11. Soil Retainer: Manufacturer’s standard size to verify configuration and color selected.
D. Certification from an approved independent testing laboratory experienced in testing rubberized asphalt material, that the material meets the CGSB-37.50-M89 standard for rubberized asphalt membranes, including applicable ASTM procedures.

E. Certification showing full time quality control of production facilities responsible for the manufacture of the rubberized asphalt and that each batch of material is tested to insure conformance with the manufacturer's published physical properties.

F. Certification showing that all components of the green roof assembly are being supplied and warranted by a single-source manufacturer.

G. Evidence that the roof membrane assembly is currently Class A listed with Underwriters Laboratories.

H. Evidence that the extruded polystyrene insulation if used is free from CFC's.

I. Evidence that the rubberized asphalt membrane product contains an inert clay filler and crumb rubber to enable the product to be resistant to acids (fertilizers, building washes and acid rain) and maintain membrane thickness during application.

J. The plant manufacturing the rubberized asphalt material must have ISO9002 approval as evidenced by a notarized copy of the official certificate.

K. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.

L. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

1. Submit evidence of meeting performance requirements.

M. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of roofing system.

N. Research/Evaluation Reports: For components of membrane roofing system.

O. Maintenance Data: For roofing system to include in maintenance manuals.

P. Sample Warranty: Submit manufacturer's warranty showing compliance with provisions of this Section.

Q. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.

R. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

1.8 QUALITY ASSURANCE

A. Single Source Responsibility: Perform waterproofing system as specified in this system, and also garden roof plantings and soil and specified in Section 32, as single system under responsibility of waterproofing manufacturer.
B. The Roofing/Waterproofing Contractor shall demonstrate qualifications to perform the work of this Section by submitting the following documentation:

1. Certification or license by the membrane manufacturer as a locally based, authorized applicator of the product the installer intends to use, for a minimum of five (5) years.
2. List of at least three (3) projects, satisfactorily completed within the past five (5) years, of similar scope and complexity to this project. Previous experience submittal shall correspond to specific membrane system proposed for use by applicator.

C. Membrane Manufacturer Qualifications: Manufacturer shall demonstrate qualifications to supply materials of this section by certifying the following:

1. Membrane Manufacturer must show evidence that the specified rubberized asphalt has been manufactured by the same source for fifteen (15) years and successfully installed on a yearly basis for a minimum of fifteen (15) years on projects of similar scope and complexity.
2. Membrane Manufacturer must not issue warranties for terms longer than they have been manufacturing their hot fluid rubberized asphalt membrane.
3. Maintain locally available representation for technical and inspection support services.
4. Maintain locally available landscape installer on retainage to install soil and planting and maintain planting for one year following work of this Section.

D. Manufacturer's Technical Representative: Available on site to make interim observations, recommendations, and final inspection. Available to verify installation in conformance with manufacturer's Warranty provisions.

E. Preinstallation Conference: Conduct conference at Project site approximately 2 weeks prior to beginning work of this section. Conference shall be attended by GC/CM, waterproofing applicator, planting installer, Owner, Architect, manufacturer's representative, and as requested to attend.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original unopened containers of packaging clearly labeled with manufacturer's name, brand name, instruction for use, all identifying numbers, and U.L. labels.

B. Materials shall be stored in a neat, safe manner, not to exceed the allowable structural capacity of the storage area.

C. Store materials in a clean, dry area protected from water and direct sunlight.

D. Store all adhesives at temperatures between 60°F (15.5°C) and 80°F (26.6°C). If exposed to lower temperatures, restore materials to 60°F (15.5°C) minimum temperature before using.

1.10 PROJECT CONDITIONS

A. Application of the membrane shall not commence nor proceed during inclement weather. All surfaces to receive the membrane shall be free of water, dew, frost, snow and ice.

B. Application of membrane shall not commence nor proceed when the ambient temperature is below 0°F (-17.7°C).

C. Preparation and application of membrane must be conducted in well ventilated areas.

D. Over its service life, do not expose membrane or accessories to a constant temperature in excess of 180°F (82°C) (i.e., hot pipes and vents or direct steam venting, etc.).
E. Adhesives contain petroleum distillates and are extremely flammable. Do not breathe vapors or use near an open fire. Do not use in confined areas without adequate ventilation. Consult container or packaging labels and Material Safety Data Sheets (MSDS) for specific safety information.

F. Do not allow waste products (petroleum, grease, oil, solvents, vegetable or mineral oil, animal fat, etc.) to come in contact with the roof membrane. Any exposure to foreign materials or chemical discharges must be presented to membrane manufacturer for evaluation to determine any impact on the roof membrane assembly performance.

G. Concrete Slab: Minimum 14 day curing time, minimum 28 day curing time preferred. Wood troweled finish preferred.

H. Temperature Exposure: Protect fluid applied membrane waterproofing from prolonged temperature conditions exceeding 180°F, such as from hot pipes and vents.

I. Fluid Applied Membrane Waterproofing Weather Exposure: Maximum 30 days before covering is required.

J. General contractor shall assure that adequate protection is provided after installation so other trades do not damage membrane.

1.11 WARRANTY

A. Upon completion of the work, the contractor must supply the owner with a single-source warranty of U.S. origin direct from the manufacturer.

B. Total System Warranty: Covers components of the green roof assembly, including membrane, flashing, insulation, root barrier, drainage/water retention mat, and filter fabric, soil and plants. Includes removal and replacement of all components including soil when supplied by and installed by manufacturer’s requirements.

1. Duration of Membrane/Flashing: 20-year (watertight condition)
2. Duration of Insulation: 20-year (80% of original thermal value; remain on the deck withstanding wind speeds not to exceed 70 mph)

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

   a. American Hydrotech, Inc.
   b. Carlisle Coatings and Waterproofing: This or other alternate manufacturers may be considered. Architect to receive all technical literature on suggested products, as well as a line by line comparison to the physical properties listed below. All such material to be submitted to Architect 10 days before bid due date.
2.2 MEMBRANE

A. Membrane shall be a hot, fluid applied, rubberized asphalt membrane meeting the CGSB-37.50-M89 standard and other pertinent physical properties:


<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>TYPICAL RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash point</td>
<td>ASTM D-92, CGSB-37.50-M89</td>
<td>&lt;500°F* (260°C)</td>
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<td>Penetration</td>
<td>ASTM D-5329, CGSB-37.50-M89</td>
<td>98 mm @77°F (25°C), 187 mm @122°F (50°C)</td>
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<td>Flow</td>
<td>ASTM D-5329, CGSB-37.50-M89</td>
<td>1.0 mm @ 140°F (60°C)</td>
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<td>Toughness</td>
<td>CGSB-37.50-M89</td>
<td>16.0 Joules</td>
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<tr>
<td>Ratio of Toughness to Peak Load</td>
<td>CGSB-37.50-M89</td>
<td>0.069</td>
</tr>
<tr>
<td>Water Vapor Permeability</td>
<td>ASTM E-96, PROCEDURE E, CGSB-37.50-M89</td>
<td>0.3 ng/Pa(s)M²</td>
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<tr>
<td>Water Absorption</td>
<td>CGSB-37.50-M89</td>
<td>.11 gram weight gain</td>
</tr>
<tr>
<td>Low Temperature Flexibility (-25°C)</td>
<td>CGSB-37.50-M89</td>
<td>No delamination, adhesion loss, or cracking</td>
</tr>
<tr>
<td>Low Temperature Crack Bridging Ca-pability</td>
<td>CGSB-37.50-M89</td>
<td>No cracking, adhesion loss, or split-ting</td>
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<tr>
<td>Heat Stability</td>
<td>CGSB-37.50-M89</td>
<td>No change in viscosity, penetration, flow or low temperature flexibility</td>
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<tr>
<td>Viscosity</td>
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<tr>
<td>Water Resistance (5 days/50°C)</td>
<td>CGSB-37.50-M89</td>
<td>No delamination, blistering, emulsification, or deterioration</td>
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<tr>
<td>Softening Point</td>
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<td>Requirements</td>
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<tr>
<td>Resiliency</td>
<td>ASTM D-3407</td>
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<td>Pass 0°F (-18°C)</td>
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<tr>
<td>Acid Resistance</td>
<td>ASTM D-896 Procedure 7.1 (N-8)</td>
<td>Pass 50% Nitric Acid - 50% Sulfuric Acid</td>
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<tr>
<td>Resistance to Hydrostatic Pressure</td>
<td>ASTM D-08.22 Draft 2</td>
<td>100 psi (equals 231 foot of head water)</td>
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<td>Resistance to Salt Water</td>
<td>ASTM D-896 similar 20% sodium chloride sodium carbonate calcium chloride</td>
<td>No delamination, blistering, emulsification or deterioration</td>
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<tr>
<td>Resistance to Fertilizer</td>
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<td>No delamination, blistering, emulsification or deterioration</td>
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<td>Resistance to Animal Waste</td>
<td>3-year exposure</td>
<td>No deterioration</td>
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<td>Solids Content</td>
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<tr>
<td>Shelf Life</td>
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<td>10 years (sealed)</td>
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<td>Specific Gravity</td>
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<td>1.23 + .02</td>
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</table>

*102°F more than the application temperature recommended by the manufacturer.

### 2.3 REINFORCING

**A.** Spunbonded polyester fabric (standard duty) reinforcing sheet.

1. **Basis-of-Design:** American Hydrotech, Inc., Flex Flash F®

**B.** 60-mil (1.5 mm) thick, uncured neoprene (heavy duty) reinforcing sheet

1. **Basis-of-Design:** American Hydrotech, Inc., Flex Flash UN®

### 2.4 FLASHING

**A.** 60-mil (1.5 mm) thick, uncured neoprene sheet.

1. **Basis-of-Design:** American Hydrotech, Inc., Flex Flash UN®

### 2.5 ADHESIVES/SEALANT

**A.** Contact adhesive to bond elastomeric flashing together.

1. **Basis-of-Design:** American Hydrotech, Inc., Splicing Cement
B. Contact adhesive to bond elastomeric flashing to an approved substrate.

C. Sealant to seal elastomeric flashing seam edge.

2.6 SEPARATION / ROOT BARRIER PROTECTION COURSE

A. For extensive or semi-intensive conditions; combination of a fiberglass reinforced rubberized asphalt sheet and polyethylene root barrier.

2.7 INSULATION

A. Extruded polystyrene rigid board insulation.
   1. Basis-of-Design: STYROFOAM® Brand insulation Plazamate as manufactured by The Dow Chemical Company, marketed by American Hydrotech, Inc.
      a. Insulation shall meet ASTM C-578, Type VII.
      b. Minimum compressive strength, ASTM D-1621, 60 psi c. Maximum water absorption by volume per ASTM C-272, 0.1%
      c. Water vapor permeance for 1" product per ASTM E-96, 1.0 perm (max.) (63 ng/Pa/s/m²)
      d. Insulation shall have an R value of 5.0°F ft² h/ft²/Btu/in. (0.88 K m²/W) of thickness when tested at 75°F (23.9°C) mean temperature in accordance with ASTM C-518
      e. Product shall be free of CFC's

2.8 DRAINAGE / WATER RETENTION COMPONENT

A. Three-dimensional, molded panels of recycled material with drainage channels top and bottom sides and water retention reservoirs top side.

2.9 FILTER FABRIC

A. Non-woven, polymeric, goetextile fabric.

2.10 INSPECTION CHAMBERS

A. Provide manufacturer's premium inspection chambers at all roof drain locations to allow for maintenance access.

B. Provide 18 gauge stainless steel, over-drain inspection box with perforated sides and removable lid.
   1. Size: 11 inch x 11 inch w/4" flanges, or 18 inch x 18 inch w/4" flanges, as required.
   2. Height: 4-3/4 inch.
3. Extensions: 1 inch, 3 inch or 8-1/2" extension as required by depth of assembly.

2.11 STAINLESS STEEL LANDSCAPE EDGE

A. Provide “Metal Edge Restraint” by American Hydrotech, or equal.
   1. 0.1" thick stainless steel angle landscape edge with slotted vertical leg
   2. Equal vertical and horizontal legs – see Drawings for dimensions.
   3. 8’ long sections
   4. 0.375” effective slot mean diameter; 0.11 sq in total opening; 12 slots per lin ft
   5. Provide corner sections, splices, clips and connection bolts to construct a complete installation.

2.12 WASHED SMOOTH RIVER STONE

A. For perimeter drainage material, and other areas as shown on Drawings:
   1. Size ASTM D 448, size 2, ranging in size from 1 ½” to 2 ½”.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify conditions ready to receive work of this Section. Do no work until unsatisfactory conditions are corrected. Beginning work constitutes acceptance of existing conditions.

B. Through-Slab Penetrations: Rigidly installed, prepared, and sealed in accordance with waterproofing membrane manufacturer's instructions.

3.2 PREPARATION

A. Prepare substrate surfaces, including joints and seams, in accordance with manufacturer's written instructions.

B. Sweep with broom and then use air compressor to blow remaining dust and debris from substrate.

C. Verify adhesion by applying test patch of fluid applied membrane waterproofing to substrate with manufacturer’s representative present.

3.3 WATERPROOFING INSTALLATION

A. Comply with manufacturer's instructions and provisions of Contract Documents. Where in conflict, assume more stringent requirements and verify with Architect before beginning.

B. Detailing and Flashing: Comply with manufacturer’s standard instructions and details.

1. Complete work prior to beginning fluid applied membrane waterproofing application.
2. Utilize manufacturer’s prefabricated components at penetrations, as applicable.

C. Fluid Applied Horizontal Membrane Waterproofing:
1. The membrane shall be heated in double jacketed, oil bath or hot air melter with mechanical agitation, specifically designed for the preparation of a rubberized asphalt membrane.

2. Heat membrane until membrane can be drawn-free flowing at a temperature range between 350°F (176°C) and 375°F (190°C).

3. Apply monolithic coat at continuous rate, 90 mils thick (approximately 3/16", but in no case less than 1/8") minimum.


5. Follow with 125 mils thick monolithic coat for total 215 mils thick membrane system.

D. JOINTS, CRACKS, AND TERMINATIONS

1. Prepare and treat substrates to receive roofing membrane, including joints and cracks, roof drains, and penetrations, according roofing system manufacturer's written instructions.

   a. Adhere strip of elastomeric sheet to substrate in a layer of hot fluid-applied, rubberized asphalt. Extend elastomeric sheet a minimum of 6 inches (150 mm) on each side of moving joints and cracks or joints and cracks exceeding 1/8 inch (3 mm) thick, and beyond roof drains and penetrations. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.

   b. Embed strip of reinforcing fabric into a layer of hot fluid-applied, rubberized asphalt. Extend reinforcing fabric a minimum of 6 inches (150 mm) on each side of nonmoving joints and cracks not exceeding 1/8 inch (3 mm) thick, and beyond roof drains and penetrations.

      1) Apply second layer of hot fluid-applied, rubberized asphalt over reinforcing fabric.

E. Separation/Root Barrier Protection Course Installation:

1. Protection Course: Installation of a separation course is necessary in order to carry out the water test.

2. Extensive Conditions

   a. Embed the Hydroflex® 30 separation sheet/root barrier protection course into the membrane while it is still hot to insure a good bond.

   b. Overlap adjoining sheet edges (dry) a minimum of 2"-3" (50.8 mm - 76.2 mm) to insure complete coverage.

   c. Torch.

F. Water Test:

1. All horizontal roof surfaces waterproofed with fluid applied membrane shall be leak tested by means of electronic testing or by ponding water at a minimum depth of 2" (50.8 mm) for a period of 48 hours to check the integrity of the membrane installation. [C]

2. All vertical surfaces associated with the roof that have been waterproofed with fluid applied membrane shall be leak tested by means of electronic testing, since flood testing in these areas is not feasible. [C]

3. VERIFY that the structure can support the deadload weight of a watertest before testing.

4. If leaks should occur the water must be drained completely and the membrane installation repaired.

G. Root Barrier:

1. A layer of Root Stop WSF 40® shall be laid over the Hydroflex® 30, lapping adjacent sheets 5 feet (1.5 m). The WSF 40 shall be turned up all vertical, roofed/flashed surfaces to completely protect waterproofing and flashings.
3.4 RIGID INSULATION INSTALLATION

A. Loose lay over root barrier in thickness to achieve R-Value as shown on Drawings. Where not shown, assume 6 inch thick for R-30.

B. Butt joints to prevent thermal wicking. Form tightly around penetrations and edges adjoining other construction. Fill voids over 1/8 inch wide with insulation material.

3.5 AIR LAYER

A. An air layer is required between the surface of the insulation and the water retention mat. A layer of Hydrodrain® AL or 300 shall be installed over the insulation. The 4 inch (100 mm) salvage edge of the geotextile fabric overlaps adjoining sheets and can be held in place with duct tape.

3.6 DRAINAGE AND WATER RETENTION COMPONENTS INSTALLATION

A. Water Retention Mat. Where specified, a layer of Moisture Mat SSM 45® shall be installed over the root barrier (when no insulation is specified) or air layer/insulation, lapping adjacent rolls a minimum of 4 inches (100 mm). The SSM 45 shall be turned up all vertical, roofed/flashed surfaces a minimum of 6 inches (150 mm) beyond the anticipated soil level. Any excess shall be trimmed down to the level of the soil.

B. Drainage/Water Retention: Floradrain® FD 25 shall be installed with holes through the dimples on top, over the root barrier protection, water retention mat (if used) or STYROFOAM® insulation (if used). Adjacent panels may be butt together or overlapped approximately 1 inch (25 mm) and fixed together with staples/clips. Gardendrain/Floradrain® shall be cut to fit around penetrations, etc. with a heavy-duty utility knife or small toothed saw.

C. Filter Fabric: A layer of Systemfilter SF® shall be laid over the Gardendrain/Floradrain, lapping adjacent rolls a minimum of 6 inches (150 mm). Enough material shall be left to be drawn up above the anticipated soil level. Any excess shall be trimmed down to the level of the soil.

3.7 SOIL AND PLANTING

A. Install soil mix over filter fabric to thickness shown on drawings and as specified by Landscape Architect.

B. Install washed rounded river rock around perimeters as shown on Drawings.

C. Plant and maintain ground cover as specified Section 32 95 00 Roof Garden Landscaping.

3.8 FIELD QUALITY CONTROL

A. Manufacturer’s Field Services:

1. Perform inspections during interim and at completion of fluid applied membrane waterproofing application.

2. Reinspect fluid applied membrane waterproofing application just prior to covering with garden roof components and soil.

3. Make necessary repairs and promptly make oral and written report to Contractor and Architect.
3.9 ADJUSTING, PROTECTING AND CLEANING

A. Repair fluid applied membrane waterproofing with additional coatings of new fluid applied waterproofing and as instructed by manufacturer to achieve waterproof installation.

B. Leave installations clean, premises free from debris and residue resulting from work of this Section.

C. Remove stains from adjacent surfaces with manufacturer's recommended cleaning agents.

D. Protect membrane waterproof from contamination from petroleum products, grease, oil, solvents, vegetable and mineral oils, animal fat, chemicals, and other foreign material.

3.10 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:

1. Aluminum
2. Plastic Materials and Gaskets
3. Corrugated cardboard packaging.

Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 07 33 00
SECTION 07 53 23 – EPDM MEMBRANE ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Adhered EPDM membrane roofing system.
   2. Peel and stick air/vapor retarder.
   3. Roof insulation.
   4. Roof sheathing.

B. Related Sections:
   1. Division 06 Section "Rough Carpentry" for wood nailers, curbs, and blocking.
   2. Division 07 Section "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counterflashings.
   3. Division 07 Section "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.3 DEFINITIONS

A. Roofing Terminology: See ASTM D 1079 and glossary of NRCA’s "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

C. FM Approvals Listing: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals’ "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals’ markings.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For adhesives and sealants used inside the weatherproofing system, documentation including printed statement of VOC content.

C. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
1. Base flashings and membrane terminations.
2. Tapered insulation, including slopes.

D. Samples for Verification: For the following products, in manufacturer's standard sizes:
   1. Sheet roofing, of color specified, including T-shaped side and end lap seam.
   2. Air/Vapor barrier.
   3. Roof insulation.
   4. Termination bars.
   5. Roof sheathing.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and manufacturer.

B. Manufacturer Certificate: Signed by roofing manufacturer certifying that membrane roofing system complies with requirements specified in "Performance Requirements" Article.
   1. Submit evidence of complying with performance requirements.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.

D. Research/Evaluation Reports: For components of membrane roofing system.

E. Field quality-control reports.

F. Warranties: Sample of special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For membrane roofing system to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is FM Approvals approved for membrane roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

C. Source Limitations: Obtain components including roof insulation, concrete deck primer, adhesives, air/vapor barrier and other components for membrane roofing system approved by membrane roofing manufacturer.

D. Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

E. Preinstallation Roofing Conference: Conduct conference at Project site.
   1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
   2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
   3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.10 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.
   1. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, vapor retarder, roofing accessories, walkway products, and other components of membrane roofing system.
   2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 EPDM MEMBRANE ROOFING

A. EPDM: ASTM D 4637, Type II, scrim or fabric internally reinforced, uniform, flexible EPDM sheet.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Carlisle SynTec Incorporated.
      b. ERSystems.
      c. Firestone Building Products.
      d. GAF Materials Corporation.
      e. GenFlex Roofing Systems.
f. Johns Manville.
g. Roofing Products International, Inc.
h. Versico Incorporated.

2. Thickness: 90 mils, nominal.
3. Exposed Face Color: Black.

2.2 AUXILIARY MEMBRANE ROOFING MATERIALS

A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
   1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
   2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      a. Plastic Foam Adhesives: 50 g/L.
      b. Gypsum Board and Panel Adhesives: 50 g/L.
      c. Multipurpose Construction Adhesives: 70 g/L.
      d. Fiberglass Adhesives: 80 g/L.
      e. Single-Ply Roof Membrane Adhesives: 250 g/L.
      f. Single-Ply Roof Membrane Sealants: 450 g/L.
      g. Nonmembrane Roof Sealants: 300 g/L.
      h. Sealant Primers for Nonporous Substrates: 250 g/L.
      i. Sealant Primers for Porous Substrates: 775 g/L.
      j. Other Adhesives and Sealants: 250 g/L.

B. Sheet Flashing: 90-mil-thick EPDM, partially cured or cured, according to application.

C. Protection Sheet: Epichlorohydrin or neoprene non-reinforced flexible sheet, 55- to 60-mil-thick, recommended by EPDM manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil.

D. Bonding Adhesive: Manufacturer's standard.

E. Primer for Concrete Deck: Carlisle’s CCW-702 or CAV-GRIP, or equal product to be compatible with another manufacturer's roofing system.

F. Seaming Material: Single-component, butyl splicing adhesive and splice cleaner, or manufacturer's standard, synthetic-rubber polymer primer and 3-inch-wide minimum, butyl splice tape with release film.

G. Lap Sealant: Manufacturer's standard, single-component sealant, colored to match membrane roofing.

H. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.

I. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.

J. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, prepunched.

K. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.
2.3 **AIR / VAPOR BARRIER**

A. Manufacturer’s recommended Air & Vapor Barrier product that is compatible with EPDM membrane.
   1. Use Carlisle’s 725TR, or equal product by membrane manufacturer.
   2. 35 mil self-adhering rubberized asphalt laminated to 5 mil polyolefin film.

2.4 **ROOF INSULATION**

A. General: Preformed roof insulation boards manufactured or approved by EPDM membrane roofing manufacturer, selected from manufacturer’s standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation.

B. Polysocyanurate Board Insulation: ASTM C 1289, Type II, Class I, Grade 3, felt or glass-fiber mat facer on both major surfaces.
   1. Polysocyanurate Board Insulation shall be CFC- and HCFC-free.

C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope indicated in the Drawings.

D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.
   1. Maintain a minimum 4 inch insulation thickness at roof drains.

2.5 **INSULATION ACCESSORIES**

A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer. Insulation and roof membrane are to be installed using a fully adhered system. Use mechanical fasteners only where required.

C. Cold Fluid-Applied Insulation Adhesive: Manufacturer’s standard cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.

D. Roof Sheathing / Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch thick.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Georgia-Pacific Corporation; Dens Deck Prime.

**PART 3 - EXECUTION**

3.1 **EXAMINATION**

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
   1. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
   2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   3. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
4. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
5. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.3 AIR & VAPOR BARRIER INSTALLATION

A. Install air and vapor barrier over concrete deck after manufacturer's recommended concrete primer has been applied.

B. Completely seal air and vapor barrier at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

3.4 INSULATION INSTALLATION

A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with

1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

G. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:

1. Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

H. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together and fasten to roof deck.
1. Fasten cover boards according to requirements in FM Approvals’ "RoofNav" for specified Windstorm Resistance Classification.
2. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

3.5 ADHERED MEMBRANE ROOFING INSTALLATION

A. Adhere membrane roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.

B. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.

C. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.

E. Mechanically or adhesively fasten membrane roofing securely at terminations, penetrations, and perimeters.

F. Apply membrane roofing with side laps shingled with slope of roof deck where possible.

G. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
   1. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.

H. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.

I. Spread sealant or mastic bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.

3.6 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing agency to perform inspections.
B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

C. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.

D. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 PROTECTING AND CLEANING

A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.9 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Plan and coordinate roofing work to minimize the generation or cutoffs and waste.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.
   1.
SECTION 07 61 00 – FLAT SEAM METAL ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Flat-seam metal roofing, custom fabricated on site.

B. Related Sections:
   1. Division 06 Section "Sheathing."
   2. Division 07 Section "Thermal Insulation" for roof insulation.
   3. Division 07 Section "Sheet Metal Flashing and Trim" for copings, and flashings that are not part of sheet metal roofing.
   4. Division 07 Section "Joint Sealants" for field-applied sealants adjoining sheet metal roofing.

C. Definitions: The trade name “Freedom Grey” is used in this and other Sections of these Specifications to abbreviate the term “Zinc-Tin Alloy Coated Copper.” Use of this term is not intended to limit product selection to “Freedom Grey” Architectural Copper, as produced by Revere Copper Products, Inc., and acceptable equivalents will be considered, subject to compliance with all requirements.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Sheet metal roofing system including, but not limited to, metal roof panels, cleats, clips, anchors and fasteners, sheet metal flashing integral with sheet metal roofing, fascia panels, trim, underlayment, and accessories shall comply with requirements indicated without failure due to defective manufacture, fabrication, installation, or other defects in construction. Sheet metal roofing shall remain watertight.

B. Roofing System Design:
   1. Corner Uplift Pressure: As determined by design criteria and applicable building codes indicated on the Drawings.
   2. Perimeter Uplift Pressure: As determined by design criteria and applicable building codes indicated on the Drawings.
   3. Field-of-Roof Uplift Pressure: As determined by design criteria and applicable building codes indicated on the Drawings.

C. Thermal Movements: Provide sheet metal roofing that allows for thermal movements from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
B. Shop Drawings: Show fabrication and installation layouts of sheet metal roofing, including plans, elevations, expansion joint locations, and keyed details. Distinguish between shop- and field-assembled work. Include the following:
   1. Details for forming sheet metal roofing and sheet metal ceiling panels, including seams and dimensions.
   2. Details for joining and securing sheet metal roofing and sheet metal ceiling panels, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
   3. Details of termination points and assemblies, including fixed points.
   4. Details of expansion joints, including showing direction of expansion and contraction.
   5. Details of roof penetrations.
   6. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings.
   7. Details of special conditions.
   8. Details of connections to adjoining work.
   9. Detail the following accessory items, at a scale of not less than 3 inches per 12 inches:
      a. Flashing and trim.
      b. Gutters and downspouts as they relate to adjacent sheet metal roofing.

C. Samples for Initial Selection: For each type of sheet metal roofing and ceiling panel indicated, with factory-applied color finishes.
   1. Include similar Samples of trim and accessories involving color selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
   1. Sheet Metal Roofing and Ceiling Panel: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, and other attachments.
   2. Trim and Metal Closures: 12 inches long and in required profile. Include fasteners and other exposed accessories.
   3. Other Accessories: 12-inch long Samples for each type of other accessory.

E. Coordination Drawings: Roof plans and reflected ceiling plans drawn to scale with coordinated details for penetrations and roof-mounted items.

F. Qualification Data: For qualified Installer/fabricator.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

H. Maintenance Data: For roofing sheet metals and accessories to include in maintenance manuals.

I. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Custom-Fabricated Sheet Metal Roofing Fabricator Qualifications: Shop that employs skilled workers who custom fabricate sheet metal roofing similar to that required for this Project and whose products have a record of successful in-service performance. Provide documentation for five (5) roof installations on projects of similar size and scope in the Pennsylvania, New York or New England region during the last ten (10) years.

B. Copper Roofing Standard: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

C. Sheet Metal Roofing Standard: Comply with "Copper & Common Sense" by Revere Copper Products, Inc., unless more stringent requirements are specified or shown on the Drawings.
D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
1. As sheet metal work proceeds, build mockups of each type of roof and ceiling area, including accessories.
   a. Size: 4’ x 8’
   b. Flat seam roof.
   c. Include every type of joint and termination in mockup.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preliminary Roofing Conference: Before starting roof deck and/or sheathing construction, conduct conference at Project site. Comply with requirements for pre-installation conferences in Division 01 Section "Project Management and Coordination."
1. Review methods and procedures related to roof deck and/or sheathing construction and sheet metal roofing including, but not limited to, items listed for the Pre-installation Conference.

F. Pre-installation Conference: Conduct conference at Project site.
1. Meet with Owner, Architect, Owner's insurer if applicable, sheet metal roofing Installer and installers whose work interfaces with or affects sheet metal roofing.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to sheet metal roofing installation.
4. Examine sheathing conditions for compliance with requirements, including flatness and attachment to structural members.
5. Review structural loading limitations of roof framing and sheathing during and after roofing installation.
6. Review flashings, special roofing details, roof drainage, roof penetrations, and condition of other construction that will affect sheet metal roofing.
7. Review governing regulations and requirements for insurance, certificates, and testing and inspecting if applicable.
8. Review temporary protection requirements for sheet metal roofing during and after roofing installation.
10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal roofing materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal roofing materials away from uncured concrete and masonry.

B. Protect strippable protective covering on sheet metal roofing from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal roofing installation.

1.7 COORDINATION

A. Coordinate sheet metal roofing with rain drainage work, flashing, trim, and construction of metal decks, sheathing, parapets, walls, and other adjoining work to provide a leak proof, secure, and noncorrosive installation.
1.8 WARRANTY

A. Special Warranty: Warranty form at the end of this Section in which Installer agrees to repair or replace components of sheet metal roofing that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures, including but not limited to rupturing, cracking, or puncturing.
      b. Wrinkling or buckling.
      c. Loose parts.
      d. Failure to remain weathertight, including uncontrolled water leakage.
      e. Deterioration of metals, metal finishes, and other materials beyond normal weathering, including non-uniformity of color or finish.
      f. Galvanic action between sheet metal roofing and dissimilar materials.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ROOFING SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.

B. Zinc-Tin Alloy-Coated Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper, coated on both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin).
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Revere Copper Products, Inc.; FreedomGray.
   2. Weight (Thickness): 16-oz./sq. ft. uncoated weight, with 0.787-mil coating thickness applied to each side.

2.2 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
   2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F.
   3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Carlisle Coatings & Waterproofing Inc.; CCW WIP 300HT.
      c. Henry Company; Blueskin PE200 HT.
      d. Metal-Fab Manufacturing, LLC; MetShield.
      e. Owens Corning; WeatherLock Metal High-Temperature Underlayment.

B. Slip Sheet: Building paper, 3-lb/100 sq. ft. minimum, rosin sized.

2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for a complete roofing and ceiling system and as recommended by fabricator for sheet metal roofing.
B. Fasteners: Wood screws, annular-threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.
   1. Fasteners for Zinc-Tin Alloy-Coated Copper Sheet: Copper, hardware bronze, or Series 300 stainless steel.

C. Solder:
   1. For Zinc-Tin Alloy-Coated Copper: ASTM B 32, 100 percent tin.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

E. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane, polysulfide, or silicone polymer sealant as recommended by portable roll-forming equipment manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal roofing and remain watertight.

F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.4 ACCESSORIES

A. Sheet Metal Accessories: Provide components required for a complete sheet metal roofing assembly including trim, copings, fasciae, corner units, clips, flashings, sealants, gaskets, fillers, metal closures, closure strips, and similar items. Match material and finish of sheet metal roofing unless otherwise indicated.
   1. Provide accessories as recommended by portable roll-forming equipment manufacturer to produce sheet metal roofing assemblies that comply with UL 580 for wind-uplift resistance classification specified in "Quality Assurance" Article.
   2. Cleats: For mechanically seaming into joints and formed from the following materials:
      a. Zinc-Tin Alloy-Coated Copper Roofing: Cleats to be same material and weight as the roofing or wall cladding material.
   3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible-closure strips; cut or premolded to match sheet metal roofing profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
   4. Flashing and Trim: Formed from same material and with same finish as sheet metal roofing and ceiling, minimum thickness matching the sheet metal roofing.
   5. Fins & Edge Strips: Heavy gage projecting metal elements illustrated in the Drawings including projecting edge strips at reveals.
      a. 32 oz. Zinc-Tin Alloy-Coated Copper.
      b. Solid bronze bar stock as shown in Drawings.

2.5 FABRICATION

A. General: Custom fabricate sheet metal roofing to comply with details shown and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions (panel width and seam height), geometry, metal thickness, and other characteristics of installation indicated. Fabricate sheet metal roofing and accessories at the shop to greatest extent possible.
   1. Flat-Seam Roofing: Form flat-seam panels from metal sheets 20 by 28 inches with 1/2-inch notched and folded edges.

B. Fabrication Tolerances: Fabricate sheet metal roofing and ceiling panels that are capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
C. Form exposed sheet metal work to fit substrates without excessive oil canning, buckling, and tool marks; true to line and levels indicated; and with exposed edges folded back to form hems.
1. Lay out sheet metal roofing so transverse seams, if required, are made in direction of flow with higher panels overlapping lower panels.
2. Offset transverse seams from each other 12 inches minimum.
3. Form and fabricate sheets, seams, strips, cleats, edge treatments, integral flashings, and other components of metal roofing to profiles, patterns, and drainage arrangements shown on Drawings and as required for leak proof construction.

D. Expansion Provisions: Fabricate sheet metal roofing to allow for expansion in running work sufficient to prevent leakage, damage, and deterioration of the Work. Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

E. Sealant Joints: Where movable, nonexpansion-type joints are indicated or required to produce weathertight seams, form metal to provide for proper installation of elastomeric sealant in compliance with SMACNA standards.

F. Metal Protection: Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with bituminous coating, by applying self-adhering sheet underlayment to each contact surface, or by other permanent separation as recommended by fabricator of sheet metal roofing or manufacturers of the metals in contact.

G. Sheet Metal Accessories: Custom fabricate flashings and trim to comply with recommendations in SMACNA’s "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.
1. Form exposed sheet metal accessories without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
2. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
3. Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.

H. Do not use graphite pencils to mark metal surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
1. Examine solid roof and ceiling sheathing to verify that sheathing joints are supported by framing or blocking, that tops of fasteners are flush with surface, and that installation is within flatness tolerances required for finished roofing installation.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored, and that provision has been made for drainage, flashings, and penetrations through sheet metal roofing.

B. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
C. Examine roughing-in for components and systems penetrating sheet metal roofing to verify actual locations of penetrations relative to seam locations of sheet metal roofing before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free, on roof sheathing under sheet metal roofing. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply at locations indicated, in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.
1. Cover entire vestibule roof with self-adhering sheet underlayment.

B. Install flashings to cover underlayment to comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim."

C. Apply slip sheet before installing sheet metal roofing.

3.3 INSTALLATION, GENERAL

A. General: Anchor sheet metal roofing and other components of the Work securely in place, with provisions for thermal and structural movement. Install fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for a complete roofing system and as recommended by fabricator for sheet metal roofing.
1. Field cutting of sheet metal roofing by torch is not permitted.
2. Locate and space fastenings in uniform vertical and horizontal alignment. Predrill panels for fasteners.
3. Install sealant tape where indicated.
4. Lap metal flashing over sheet metal roofing to allow moisture to run over and off the material.
5. Do not use graphite pencils to mark metal surfaces.

B. Thermal Movement. Rigidly fasten metal roof panels to structure at only one location for each panel. Allow remainder of panel to move freely for thermal expansion and contraction.
1. Point of Fixity: Fasten each panel along a single line of fixing located at center of panel length.
2. Avoid attaching accessories through roof panels in a manner that will inhibit thermal movement.

C. Fasteners: Use fasteners of sizes that will penetrate wood sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.

D. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying self-adhering sheet underlayment to each contact surface, or by other permanent separation as recommended by SMACNA.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
3.4 CUSTOM-FABRICATED FLAT SEAM SHEET METAL ROOFING INSTALLATION

A. Fabricate and install work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves, and avoidable tool marks, considering temper and reflectivity of metal. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant. Fold back sheet metal to form a hem on concealed side of exposed edges unless otherwise indicated.
   1. Install cleats to hold sheet metal panels in position. Attach each cleat with two fasteners to prevent rotation.
   2. Fasten cleats not more than 12 inches o.c. Bend tabs over fastener head.
   3. Provide expansion-type cleats and clips for roof panels that exceed 30 feet in length.

B. Seal joints as shown and as required for watertight construction. For roofing with 3:12 slopes or less, use cleats at transverse seams.
   1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
   2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

C. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches, except reduce pre-tinning where pre-tinned surface would show in completed Work.
   1. Do not pre-tin zinc-tin alloy-coated copper.
   2. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
   3. Copper Roofing: Tin edges of uncoated copper sheets, using solder for copper.

D. Flat-Seam Roofing: Attach flat-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge. After panels are in place, mallet seams and solder.
   1. Attach roofing panels with cleats spaced not more than 24 inches o.c.. Lock and solder panels to base flashing.
   2. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at 12 inches o.c. Lock panels to edge flashing and solder.

3.5 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
   1. Install components required for a complete sheet metal roofing assembly including trim, copings, seam covers, flashings, sealants, gaskets, fillers, metal closures, closure strips, and similar items.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and "Copper & Common Sense." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
   1. Install flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
   2. Install continuous strip of self-adhering underlayment at edge of continuous flashing overlapping self-adhering underlayment, where "continuous seal strip" is indicated in "Copper & Common Sense," and where indicated on Drawings.
3. Install exposed flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

4. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep and filled with butyl sealant concealed within joints.

3.6 ROOF DRAINAGE SYSTEM INSTALLATION

A. General: Install sheet metal roof drainage items to product complete roof drainage system according to “Copper & Common Sense” recommendations and as indicated.

B. Coordinate with the requirements of the roof and gutter ice melt system.

3.7 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal roofing within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.8 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

D. Remove temporary protective coverings and strippable films as sheet metal roofing is installed unless otherwise indicated in manufacturer’s written installation instructions. On completion of sheet metal roofing installation, clean finished surfaces as recommended by sheet metal roofing manufacturer. Maintain sheet metal roofing in a clean condition during construction.

E. Replace sheet metal roofing components that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

3.9 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.
END OF SECTION 07 61 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Manufactured Products:
   a. Manufactured through-wall flashing and counterflashing.
   b. Manufactured reglets and counterflashing.

2. Formed Products:
   a. Formed roof drainage sheet metal fabrications.
   b. Formed low-slope roof sheet metal fabrications.
   c. Formed wall sheet metal fabrications.
   d. Formed equipment support flashing.
   e. Formed overhead-piping safety pans.

B. Related Sections: Sheet metal flashing and trim work related to the work specified in the following Sections is work of the following Sections but shall also comply with the requirements of this Section. The additional requirements specified under this section include, but are not limited to, detailed coordination of shop drawings, materials, and installation with work specified in the following Sections:

1. Division 04 Section "Unit Masonry" and "Stone Masonry" for installing sheet metal flashing and trim integral with masonry work.
2. Division 06 Section "Rough Carpentry" for wood nailers, curbs, and blocking.
3. Division 07 Section "Self-Adhering Sheet Waterproofing" for installing sheet metal flashing and trim integral with waterproofing work.
4. Division 07 Section "EPDM Roofing" for installing sheet metal flashing and trim integral with membrane roofing.
5. Division 07 Section "Flat Seamed Metal Roofing" for custom-formed sheet metal flashing and trim integral with metal siding.
6. Division 07 Section "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
7. Division 07 Section "Joint Sealants" for elastomeric sealants work related to sheet metal flashing and trim work.
8. Division 07 Section "Fluid-Applied Air and Vapor Barrier" for installation of sheet metal flashing and trim in conjunction with air and vapor barrier systems.
10. Divisions 22 through 28 for sheet metal flashing and trim work related to mechanical, plumbing, and electrical work. All mechanical, plumbing, and electrical systems flashing, counter flashing, and other sheet metal flashing and trim work not indicated as work of Divisions 22 through 28 is work of this section and shall be installed integral with related roofing or other work.

C. All concealed unpainted and exposed pre-finished sheet metal flashing and trim work for the entire project (interior and exterior) is work of this section except as otherwise indicated.
1.3 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Fabricate and install roof edge flashing and copings and other sheet metal flashing and trim capable of resisting the following forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for Wind Zone of project area.

C. Thermal Movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, submit manufacturer's product data, installation instructions and general recommendations for each specified sheet material and fabricated product, system, and accessory. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory. Include data substantiating that materials and performance comply with specified requirements.

B. Shop Drawings: Show fabrication and installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Submit complete shop drawings showing layout, joining, profiles, and anchorages of each fabricated item and system, including all counter-flashings and detail conditions; layouts at 1/4" scale, details at 3" scale. Distinguish between shop- and field-assembled work. Include the following:
   1. Identification of material, thickness, weight, and finish for each item and location in Project.
   2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
   3. Details for joining, supporting, and securing sheet metal flashing and trim, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
   4. Details of termination points and assemblies, including fixed points.
   5. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction.
   6. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
   7. Details of special conditions.
   8. Details of connections to adjoining work.
   9. Detail formed flashing and trim at a scale of not less than 3 inches per 12 inches.
   10. For copings, gutters, scuppers, downspouts and exposed flashing and trim submit complete shop drawings and details indicating layout with joint locations, joining, prefabricated corners, prefabricated transitions, concealed splices, expansion joints, profiles, accessories, flashing connections and relationship to supporting structure and to adjoining roof and wall construction.

C. Samples for Initial Selection: For each type of sheet metal flashing, trim, and accessory indicated with factory-applied color finishes involving color selection. Submit samples of each specified sheet material and fabricated product to be exposed as finish surfaces with the specified finishes in custom colors to match samples provided by the Architect.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
   1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.

3. Accessories and Miscellaneous Materials: Full-size Sample.

4. Prefinished Aluminum Samples: Samples to show full range to be expected for each color required.

5. For verification purposes submit completely finished samples of prefabricated welded corner units for each type of gravel stop and coping and finish required.

E. Qualification Data: For qualified fabricator. Qualification data for firms and persons specified in the "Quality Control" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

F. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

G. Maintenance Data: For sheet metal flashing, trim, and accessories to include in maintenance manuals.

H. Warranty: Sample of special warranty.

I. Installation and fastening data showing compliance with FM Loss Prevention Data Sheet 1-49.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Engage an experienced Installer who has completed sheet metal flashing and trim work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

C. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

D. Copper Sheet Metal Standard: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

E. Shop Assembly: Preassemble items in the shop to the greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Wall Mockup:
   a. Build mockup of typical wall area to include sheet metal flashing and trims typically associated with the following wall construction types:
      1) brick
      2) dimension stone
      3) aluminum curtain wall

2. Architect will issue drawings to further describe extent of mockup.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

G. Preinstallation Conference: Conduct conference at Project site.
   1. Meet with Owner, Architect, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
   2. Review methods and procedures related to sheet metal flashing and trim.
   3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
   4. Review special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect sheet metal flashing.
   5. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

1.7 PROJECT CONDITIONS

A. Coordinate work of this section with interfacing and adjoining work for proper sequencing of each installation. Ensure best possible weather resistance and durability of the work and protection of materials and finishes.
   1. Each contractor responsible for sheet metal flashing and trim work shall furnish to other contractors responsible for adjoining work all reglets and other required accessories that are required to be installed by other contractor's in their work. Coordinate reglets and accessories with substrate type and flashing materials and systems. Coordinate installation with wall and roof systems.

1.8 WARRANTY

A. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
B. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.
   1. Surface: Smooth, flat.
   2. Exposed Coil-Coated Finishes:
      a. Metallic Fluoropolymer: AAMA 620. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   3. Color: Match Architect's samples. Three colors will be used.
   4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

C. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed.
   1. Finish: 2D (dull, cold rolled).
   2. Surface: Smooth, flat.

D. Zinc-Tin Alloy-Coated Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper, of minimum uncoated weight (thickness) indicated; coated on both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin).
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Revere Copper Products, Inc.; FreedomGray.
   2. Weight: Weights indicated in this Section and on the drawings refer to the uncoated weight of the copper sheet. All zinc-tin alloy-coated copper sheet material shall have a 0.787-mill coating thickness applied to each side.

2.2 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
   1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
      b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
      c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
   2. Fasteners for Zinc-Tin Alloy-Coated Copper Sheet: Copper, hardware bronze or Series 300 stainless steel.
   3. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
   4. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.

C. Solder:
   1. For Stainless Steel: ASTM B 32, Grade Sn60, with an acid flux of type recommended by stainless-steel sheet manufacturer.
   2. For Zinc-Tin Alloy-Coated Copper: ASTM B 32, 100 percent tin.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
E. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight. Comply with recommendations by sheet metal manufacturer and fabricator of components being sealed and comply with requirements for joint sealants as specified in Division 7 Section "Joint Sealants."

F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints in materials that are not pre-finished, including riveted joints.

H. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187, compounded for 15 mil dry film thickness per coat.

I. Asphalt Roofing Cement: Subject to coordination with, and compliance with requirements indicated in, applicable Division 7 Sections, provide asphalt type ASTM D 4586, asbestos free, of consistency required for application.

J. Adhesives: Type recommended by sheet metal manufacturer for substrate and project conditions for waterproof and weather-resistant seaming and adhesive application of sheet metal, and formulated to comply with performance requirements indicated in section 1.3 above.

K. Foam Rubber Seal: Manufacturer's standard foam.

L. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of the counterflashing lower edge.

M. Joint Cap: Soft lead joint protection cap, Weather Cap, Inc., Model A4 or approved equal, at horizontal reglet into which stainless steel flashing is installed.

2.3 MANUFACTURED SHEET METAL FLASHING AND TRIM

A. Concealed Sheet Metal Flashing:
   1. Stainless-Steel Sheet: ASTM A 167, Type 302304, soft annealed, with No.2D finish, except where harder temper is required for forming or performance; minimum 0.0156 inch thick, unless otherwise indicated.

B. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated and with substrate and installation condition indicated, with factory-mitered and -welded corners, transitions and junctions, and with interlocking counterflashing on exterior face, of same metal and finish as flashing.
   1. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
   2. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
   3. Flexible Flashing Retainer: Provide neoprene plastic or rubber accessory to secure roofing or stainless Steel flashing in reglet where clearance does not permit use of standard metal counterflushing or where Drawings show reglet without metal counterflushing.
   4. Basis-of-Design Product: Reglet Flashing System shall be Type A (at concrete) or Type B (at masonry) reglet and spring lock cap flashing as manufactured by Cheney Flashing Co. or approved equal, in dimensions as shown on the drawings. Reglets shall be compatible with and noncorrosive to flashing indicated or comparable product by one of the following:
      a. Cheney Flashing Company.
b. Fry Reglet Corporation.
c. Heckmann Building Products Inc.
d. Hickman, W. P. Company.
e. Hohmann & Barnard, Inc.; STF Sawtooth Flashing.
g. National Sheet Metal Systems, Inc.
h. Sandell Manufacturing Company, Inc.

5. Material: Stainless steel, 0.019 inch thick.

6. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.

7. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.

8. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.

9. Accessories:
   a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
   b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

10. Finish: 2B, unless noted otherwise.

2.4 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA’s "Architectural Sheet Metal Manual" and other recognized industry practices that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated, and comply with additional requirements indicated on the drawings or specified herein. Fabricate items at the shop to greatest extent possible. Fabricate to fit substrates and result in waterproof and weather-resistant performance; with expansion provisions for running work, sufficient to permanently prevent leakage, damage or deterioration of the work. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal. Comply with material manufacturer instructions and recommendations for forming material.

1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

2. Obtain field measurements for accurate fit before shop fabrication.

3. Form sheet metal flashing and trim without oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

4. Conceal fasteners and expansion provisions. Exposed fasteners are not allowed on faces exposed to view unless unavoidable AND only with the Architect’s prior written approval. Where unavoidable and approved by the Architect, provide Phillips flat-head machine screws for exposed fasteners and match finish of exposed heads with material being fastened, unless otherwise indicated. Except as otherwise indicated fasteners shall be same metal as flashing/sheet metal, non-magnetic stainless steel or other noncorrosive metal as recommended by sheet manufacturer, and of size recommended by the manufacturer, for product and application indicated.

5. Provide for separation of metal from noncompatible metal or corrosive substrates by coating concealed surfaces at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer and as confirmed to be compatible with, and approved by the manufacturer of, adjacent materials. All mastics, sealants, seam sealers, adhesives and similar products proposed for use shall be selected (and tested if required) to assure that they are compatible with adjacent materials.
B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a
tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of
adjoining faces and of alignment of matching profiles.

C. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric
sealant.

D. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints
of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within
joints.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from
compatible, noncorrosive metal recommended by sheet metal manufacturer.

F. Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural
Sheet Metal Manual" and by FMG Loss Prevention Data Sheet 1-49 for application, but not less
than one gauge heavier than thickness of metal being secured.

G. Anchors and Inserts: Use non-ferrous metal or hot-dip galvanized anchors and inserts for exterior
installations and elsewhere as required for corrosion resistance. Use toothed steel or lead
expansion bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into
cement or masonry work

H. Seams that are visible in finish construction: Fabricate nonmoving seams with flush butt-joint
soldered seams. For metal other than aluminum, tin edges to be seamed, form seams, and solder.
For work indicated to receive painted, coated, or lacquered finishes, pre-fabricate and solder
nonmoving seams prior to applying finishes.

I. Seams that are concealed in finish construction: Fabricate nonmoving seams with flat-lock seams.
For concealed materials that are pre-finished form seams and seal with elastomeric sealant unless
otherwise recommended by sealant manufacturer for intended use. For concealed materials that
are not pre-finished form seams and either solder or seal with epoxy seam sealer unless otherwise
recommended by manufacturer for intended use. If soldering is used for metal other than aluminum,
tin edges to be seamed, form seams, and solder.

J. Do not use graphite pencils to mark metal surfaces.

K. Separations: Provide for separation of metal from noncompatible metal or corrosive substrates by
coating concealed surfaces at locations of contact, with asphalt mastic or other permanent
separation as recommended by manufacturer and as confirmed to be compatible with, and
approved by the manufacturer of, adjacent materials.

L. Fabricate items to comply with requirements indicated, including those for quality, thickness and
finish of material as well as those indicating dimensions and details. Use heavier metal gages,
stiffeners or metal backing as required to produce surface flatness, free of "oil-canning", and to
impart sufficient strength for use indicated. If not otherwise indicated, provide the following
minimum thickness of metal. Comply with SMACNA "Architectural Sheet Metal Manual" and other
recognized industry practices for fabrication and installation details.
1. All aluminum exposed in finish construction: 0.063 inch thick, except as otherwise noted.
2. Aluminum base flashing: 0.040 inch thick
3. Aluminum counterflashing: 0.050 inch thick
4. Aluminum flashing receivers: 0.040 inch thick

M. Form sheet metal items in maximum lengths and keep joints to a minimum, except for exposed
sheet metal which shall have joints aligned with center line of roof beams, with center line of
mullions, OR submit shop drawings with joints located to be reviewed by Architect. Do not expose
cut edges of sheet metal except as shown. Fold back exposed ends of unsupported sheet metal to
form a 1/2" wide hem on the concealed side, or ease exposed edges with backing to a radius of
approximately 1/32". Form items with flat, flush surfaces, true to line and level, and without cracking and grain separation at bends.

N. Continuously weld all nonmoving joints and seams except where other methods of joining are indicated; grind welds smooth and flush on exposed surfaces prior to pre-finishing. Comply with AWS and other metal authorities.
   1. Use filler metals and welding procedures which will blend with and match the color of sheet metal being joined and will avoid discoloration at welds.

O. Provide straps, plates and brackets as required for support and anchorage of fabricated items to adjoining work.

2.5 COPING, ROOF EDGE AND ALL OTHER EXPOSED SHEET METAL FABRICATIONS, GENERAL:

A. Provide pre-finished factory-fabricated coping, roof edge and exposed sheet metal systems which are designed and fabricated to fit applications indicated and to perform optimally with respect to weather resistance, water-tightness, durability, strength, and uniform appearance.

B. Expansion provisions: Fabricate to allow controlled expansion in running lengths not only for movement of metal components in relationship to one another but also to adjoining dissimilar materials, including flashing and roofing membrane materials, in a manner which is sufficient to prevent water leakage, deformation or damage.

C. Form copings, roof edges and exposed sheet metal, including custom trim components, to the profiles shown, using minimum 0.063" sheet aluminum unless otherwise indicated or required to conform with referenced standards. Furnish all components required for support and installation systems. Fabricate systems to tightly close with adjoining work, and with weathertight joints at exterior installations. Coordinate dimensions and attachment methods with adjacent work.

D. Locate fasteners to be concealed except where unavoidable and subject to prior written approval by the Architect. Size to securely support the work and space to prevent buckling or waviness of the finished surface.

E. Drill and tap holes required for securing closures to other surfaces.

F. Provide gaskets of closed-cell sponge neoprene or non-curing sealing tape where shown or required for concealed, continuous seal at concealed splice plates and abutting surfaces.

G. Provide concealed support and 6" wide internal (concealed) splice plates at all joints (including custom trim closures) to hold meeting faces in flush alignment. Provide prefabricated miter trim members at corners and custom fabricated end and transition profiles where shown or required, with joints soldered or welded prior to finishing to form a watertight integral unit without distortion of the contour or the face. Conform to joint locations indicated.

H. Provide continuous hold-down cleat strips secured with 3/4" hot-dipped galvanized flat-head screws spaced maximum 16" on center.

2.6 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Custom Formed Fascias, Copings and Cornice Flashings: Custom fabricated metal assemblies. Provide accessories including inside and outside corners, special shapes and transitions with mitered corners that are soldered or welded watertight prior to applying finish.
   1. Fabricate in custom lengths required to comply with joint locations indicated below.
      a. Centerlines of curtainwall vertical mullions, if applicable.
   2. Furnish with continuous cleats to support edge of external leg and interior leg.
   3. Fabricate to dimensions and profiles indicated.
5. Fabricate from the following materials:
   a. Stainless steel: 0.016 inch.
   b. At slate shingle roof and other locations where indicated: Zinc-Tin Alloy-Coated Copper: Unless noted otherwise, provide the following:
      1) 16 oz./sq. ft. typical for trim less than 12 inches wide profiles
      2) 20 oz./sq. ft. for trim wider than 12 inch profiles.
      3) 32 oz./sq. ft. for running cleats and edge strips.

2.7 WALL SHEET METAL FABRICATIONS

A. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch-high, end dams. Fabricate from the following materials:
   1. Zinc-Tin Alloy-Coated Copper: Unless noted otherwise, provide the following:
      a. 16 oz./sq. ft. typical for trim less than 12 inches wide profiles
      b. 20 oz./sq. ft. for trim wider than 12 inch profiles.
      c. 32 oz./sq. ft. for running cleats and edge strips.
   2. Aluminum: **0.063 inch** thick.
   3. Stainless Steel: **0.016 inch** thick.

2.8 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Overhead-Piping Safety Pans: Fabricate from the following materials:
   1. Stainless Steel: 0.025 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of the Work, and verify that Work may properly commence.
   1. Verify compliance with requirements for installation tolerances of substrates.
   2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

B. Notify the Construction Manager and the Architect in writing of any unsatisfactory conditions. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the work shall constitute acceptance of the substrates and conditions.

D. Field Measurements: Perform sheet metal flashing and trim work in cooperation with other trades and Contractors. Where possible, verify size, location and placement of miscellaneous sheet metal flashing and trim work prior to fabrication. Coordinate field measurements and shop drawings with fabrication and shop assembly.

3.2 INSTALLATION, GENERAL

A. General: Comply with requirements indicated in the specifications and drawings, with manufacturer's installation instructions and recommendations, and with SMACNA "Architectural Sheet Metal Manual". Anchor sheet metal flashing and trim and other components of the Work
securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system. Coordinate with installation of all related and adjacent construction and substrates to receive work of this section as required to ensure that each element of the work performs properly, and that combined elements are waterproof and weather-resistant. Anchor products included in this section securely to structural substrates, adequate to withstand lateral and thermal stresses as well as inward and outward loading pressures.

1. Locate and place flashing and sheet metal items plumb, level and in alignment with adjacent work. Install sheet metal flashing and trim true to line and levels indicated, with exposed edges folded back to form hems. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.

2. Install sheet metal flashing and trim to fit substrates and to result in watertight and weather-resistant performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

3. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as required.

4. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.

5. Install exposed sheet metal flashing and trim without oil canning, buckling, and tool marks.

6. Install sealant tape where indicated.

7. Torch cutting of sheet metal flashing and trim is not permitted.

8. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA. Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer and as confirmed to be compatible with, and approved by the manufacturer of, adjacent materials.

1. Coat back side of uncoated aluminum and stainless-steel sheet metal flashing and trim with bituminous coating or other permanent separation where flashing and trim will contact wood, ferrous metal, or cementitious construction.

2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.


C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of third points in each bay and aligning with center line of mullions OR submit shop drawings with joints located to be reviewed by Architect, with no joints allowed within 24 inches of corner or intersection. Use concealed splice backer plates. Where lapped expansion provisions using concealed splice backer plates cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.

D. Counterflashings: Coordinate installation of counterflashings with installation of assemblies to be protected by counterflashings. Install counterflashings in reglets or receivers.

E. Equipment Support Flashing: Coordinate equipment support flashing and pre-fabricated flashing units installation with roofing and equipment installation. Weld or seal flashing to equipment support member. Install pre-fabricated units in accordance with manufacturer’s instructions.

F. Use concealed anchorages except for unavoidable conditions that have been approved in advance in writing by the Architect. Provide brass or lead washers fitted to screws where required to protect sheet metal surfaces and to make a weathertight connection.
G. Fastener Sizes: Use fasteners of sizes that will penetrate wood sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws, and metal decking not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

H. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards. Fill joint with sealant and form metal to completely conceal sealant. Seal joints as shown and as required for watertight construction.
   1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
   2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."
   3. Use joint adhesive for nonmoving joints specified not to be soldered.

I. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches, except reduce pre-tinning where pre-tinned surface would show in completed Work.
   1. Solder metallic-coated steel and aluminum sheet prior to applying finish.
   2. Pre-tinning is not required for zinc-tin alloy-coated stainless steel and zinc-tin alloy-coated copper.
   3. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
   4. Stainless-Steel Soldering: Tin edges of uncoated sheets using solder recommended for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
   5. Copper Soldering: Tin edges of uncoated copper sheets using solder for copper.

J. Rivets: Rivet joints in concealed uncoated aluminum where indicated and where necessary for strength. Use of rivets in exposed or visible locations is not permitted.

K. Seams: Except as otherwise indicated or specified, fabricate nonmoving seams in sheet metal with flat-lock seams. Tin edges to be seamed, form seams, and solder.

L. Provide concealed gaskets, flashing, sealants, and fillers, and install as the work progresses to make the installations weathertight and sealed.

M. Install reglets to receive counterflashing in manner and by methods indicated. Where shown in concrete, masonry or other work, furnish reglets to trades of such work for installation. Install counterflashing in reglets, either by snap-in seal arrangement, or by wedging in place for anchorage and filling reglet with mastic or elastomeric sealant, as indicated and depending on degree of sealant exposure.

N. Repair finishes damaged by cutting, welding, soldering and grinding operations required for shop fitting and jointing. Restore finishes and prime coats of paint so there is no evidence of corrective work. Return items which cannot be refinished in the field to the shop, make the required alterations, and refinish the entire unit or provide new units, at fabricator's option subject to the approval of the Architect.

3.3 ROOF FLASHING INSTALLATION

A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.

C. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at 16-inch centers.

D. Copings: Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated.
   1. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 16-inch centers.
   2. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch centers.

E. Copings: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.

F. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.

G. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with sealant. Secure in a waterproof manner by means of snap-in installation and sealant or lead wedges and sealant.

H. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with sealant recommended by roofing membrane manufacturer and clamp flashing to pipes that penetrate roof.

3.4 WALL FLASHING INSTALLATION

A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Through-Wall Flashing: Installation of through-wall flashing is specified in Division 04 Section "Unit Masonry."

C. Reglets: Installation of reglets is specified in Division 03 Section "Cast-in-Place Concrete" and in Division 04 Section "Unit Masonry."

D. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

3.5 MISCELLANEOUS FLASHING INSTALLATION

A. Overhead-Piping Safety Pans: Suspend pans independent from structure above as indicated on Drawings. Pipe and install drain line to plumbing waste or drainage system.

B. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.
3.6 **ERECTION TOLERANCES**

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA’s “Guide Specification for Residential Metal Roofing.”

3.7 **CLEANING AND PROTECTION**

A. Clean exposed metal surfaces in accordance with manufacturer's instructions, removing substances which might cause corrosion of metal or deterioration of finishes. Touch-up, or replace if so directed by the Architect, work with damaged metal coatings.

B. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

C. Clean and neutralize flux materials. Clean off excess solder.

D. Clean off excess sealants.

E. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, remove unused materials and clean finished surfaces. Maintain in a clean condition during construction.

F. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures as directed by the Architect.

G. Protection: Installer shall advise Construction Manager of required procedures for protection of sheet metal flashing and trim work during construction. Provide final protection and maintain conditions that ensure sheet metal flashing and trim work is without damage or deterioration other than natural weathering at the time of Substantial Completion.

3.8 **WASTE MANAGEMENT**

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum, copper, stainless steel and steel.
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 07 62 00
SECTION 07 72 00 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Roof hatches.

B. Related Sections:
   1. Division 05 Section "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
   2. Division 07 steep-slope roofing Sections for ridge vents.
   3. Division 07 low-slope roofing Sections for roofing accessories.
   4. Division 07 Section "Slate Shingles" for ridge vents and snow guards for metal roof panels.
   5. Division 07 Section "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.
   6. Division 11 Section "Fall Restraint" for safety railing systems not attached to roof-hatch curbs.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof accessories. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
   1. Size and location of roof accessories specified in this Section.
   2. Method of attaching roof accessories to roof or building structure.
   3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
   4. Required clearances.

B. Warranty: Sample of special warranty.
1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.7 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.8 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 METAL MATERIALS

A. Aluminum Sheet: ASTM B 209, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.

   1. Exposed Coil-Coated Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

B. Aluminum Extrusions and Tubes: ASTM B 221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used, otherwise mill finished.

2.2 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 1, thickness as indicated.

C. Glass-Fiber Board Insulation: ASTM C 726, thickness as indicated.

D. Polyisocyanurate Board Insulation: ASTM C 1289, thickness as indicated.

E. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.

F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

G. Underlayment:
   1. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
   2. Slip Sheet: Building paper, 3-lb/100 sq. ft. minimum, rosin sized.
H. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
   1. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.

I. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

J. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

K. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.


2.3 ROOF HATCH

A. Roof Hatches: Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.
   1. Basis-of-Design: Subject to compliance with requirements, provide Enhanced Performance Roof Hatch E-50T as manufactured by The Bilco Company, or approved equal.

B. Type and Size: Single-leaf lid, 36 by 36 inches.


D. Hatch Material: Aluminum sheet, .090, with a 4” beaded flange with formed reinforcing members. Cover shall have a heavy extruded EPDM rubber gasket which is bonded to the cover interior to ensure a continuous seal when compressed to the top surface of the curb.
   1. Finish: Mill.
   2. To be field painted as directed by Architect.

E. Construction:
   1. Insulation: Cover and curb to be insulated with 2” thick polyisocyanurate with an R-value of 12. Insulation shall be fully covered and protected by an aluminum liner.
   2. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
   3. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
   4. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
   5. Fabricate curbs to minimum height of 12 inches unless otherwise indicated.
   6. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is tapered to accommodate roof slope so that top surfaces of perimeter curb are level. Equip hatch with water diverter or cricket on side that obstructs water flow.

F. Hardware:
   1. Stainless-steel spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.
   2. Cover shall be equipped with spring latch with interior and exterior turn handles.
   3. Shall be equipped with interior and exterior padlock hasps.
      a. Provide padlock for interior hasp keyed to Owner's maintenance master. Provide 4 keys for lock.
   4. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a vinyl grip handle to permit easy release for closing.
5. Compression spring operators enclosed in telescopic tubes. Upper tube shall be outer to prevent accumulation of moisture, grit and debris inside the lower tube assembly. Lower tube shall interlock with a flanged support shoe that is bolted to the curb assembly.

G. Safety Railing System: Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.
1. Height: 42 inches above finished roof deck.
2. Posts and Rails: Galvanized-steel pipe, 1-1/4 inches in diameter or galvanized-steel tube, 1-5/8 inches in diameter.
3. Flat Bar: Galvanized steel, 2 inches high by 3/8 inch thick.
5. Chain Passway Barrier: Galvanized proof coil chain with quick link on fixed end.
7. Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
8. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members.
9. Fabricate joints exposed to weather to be watertight.
10. Fasteners: Manufacturer's standard, finished to match railing system.
12. Required at one hatch location.

2.4 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install roof accessories according to manufacturer's written instructions.
   1. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
   2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
   3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
   1. Coat concealed side of uncoated aluminum or stainless-steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
   2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene sheet.

C. Roof-Hatch Installation:
   1. Install roof hatch so top surface of hatch curb is level.
   2. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
   3. Attach safety railing system to roof-hatch curb.
   4. Attach ladder-assist post according to manufacturer’s written instructions.

D. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780.

B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Division 09 painting Sections.

C. Clean exposed surfaces according to manufacturer’s written instructions.

D. Clean off excess sealants.

E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

3.4 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 07 72 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:
   1. Sprayed fire-resistive materials (SFRM).
   2. Thin-film intumescent mastic fire-resistive coatings.
   3. Surface preparation for coatings listed above.

B. Related Requirements:
   1. Division 09 Section "Structural Steel Framing" for surface conditions required for structural steel receiving SFRM.
   2. Division 07 Section “Penetration Firestopping” for fire-resistance-rated firestopping systems.
   3. Division 09 Sections “Interior Painting” for general painting.
      a. Thin film intumescent mastic fire-resistant coatings shall be compatible with primer paint and materials specified in other Sections.

C. It shall be clearly understood that all thin-film intumescent mastic fire-resistant coating work will be exposed in the finished construction and highly visible. The provision of a smooth, even and fine texture and uniform finish equivalent in appearance to applying a standard stipple enamel paint finish on steel is a contract requirement. Remedial work including grinding and sanding to remove surface imperfections and assure that material fibers will not be visible in the finished work shall be provided as required. The coating shall accurately follow the profiles of the steel members with sharp straight lines and special care and attention shall be given to flange edges, stiffener plates and holes through the steel members. Surface irregularities and imperfections including irregular lines, rough or irregular texture, laps, skid marks, brush marks, runs, sags, or ropiness shall be cause for rejection. Protective measures shall be provided to assure that there will be no overspray on to adjacent surfaces including steel decking, aluminum railing fabrications, steel hanger rods and fasteners, and stone. The Prime Contractor shall institute all measures and procedures necessary to assure that these finish quality requirements will be complied with including but not limited to applying the material in multiple thin coats to achieve the required performance thickness and utilizing experienced finishing personnel.

D. Stipple Enamel Finish for thin-film intumescent mastic fire-resistant coatings: Roll and redistribute paint o an even and fine texture. Leave no evidence of rolling such as laps, irregularity in texture, skid marks, or other surface imperfections.

E. Pigmented (Opaque) Finishes for thin film intumescent mastic fire-resistant coatings: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness or other surface imperfections will not be acceptable.

1.3 DEFINITIONS

A. SFRM: Sprayed fire-resistant material.
B. Concealed: Fire-resistive materials applied to surfaces that are concealed from view behind other construction when the Work is completed and have not been defined as exposed.

C. Exposed: Fire-resistive materials applied to surfaces that are exposed to view when the Work is completed, that are accessible through suspended ceilings, that are in elevator shafts and machine rooms, that are in mechanical rooms, that are in air-handling plenums, that are visible through linear wood panel grille ceilings, that are concealed by ceiling construction above the mezzanine, and that are identified as exposed on Drawings.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Credit EQ 4.2: For paints and coatings, documentation including printed statement of VOC content.

C. Shop Drawings: Framing plans, schedules, or both, indicating the following:
   1. Extent of fireproofing for each construction and fire-resistance rating.
   2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
   3. Minimum fireproofing thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
   4. Treatment of fireproofing after application.

D. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard dimensions in size.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer and testing agency.

B. Product Certificates: For each type of fireproofing.

C. Evaluation Reports: For fireproofing, from ICC-ES.

D. Preconstruction Test Reports: For fireproofing.

E. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by fireproofing manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution.
   1. Build mockup of each type of fireproofing and different substrate and each required finish as directed by Architect.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified testing agency to perform preconstruction testing on field mockups of fireproofing.
   1. Provide test specimens and assemblies representative of proposed materials and construction.

B. Preconstruction Adhesion and Compatibility Testing: Test for compliance with requirements for specified performance and test methods.
   1. Bond Strength: Test for cohesive and adhesive strength according to ASTM E 736. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
   2. Density: Test for density according to ASTM E 605. Provide density indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
   3. Verify that manufacturer, through its own laboratory testing or field experience, attests that primers or coatings are compatible with fireproofing.
   4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   5. For materials failing tests, obtain applied-fireproofing manufacturer's written instructions for corrective measures including the use of specially formulated bonding agents or primers.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to Project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, shelf life if applicable, and fire-resistance ratings applicable to Project.

B. Use materials with limited shelf life within period indicated. Remove from Project site and discard materials whose shelf life has expired.

C. Store materials inside, under cover, and aboveground; keep dry until ready for use. Remove from Project site and discard wet or deteriorated materials.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not apply fireproofing when ambient or substrate temperature is 44 deg F or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of fireproofing, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fireproofing dries thoroughly.

1.11 COORDINATION

A. Sequence and coordinate application of SFRM with other related work specified in other Sections to comply with the following requirements:
   1. Provide temporary enclosure as required to confine spraying operations and protect the environment.
   2. Provide temporary enclosures for applications to prevent deterioration of fire-resistive material due to exposure to weather and to unfavorable ambient conditions for humidity, temperature, and ventilation.
3. Avoid unnecessary exposure of fire-resistant material to abrasion and other damage likely to occur during construction operations subsequent to its application.

4. Do not apply fire-resistant material to metal roof deck substrates until concrete topping, if any, has been completed. For metal roof decks without concrete topping, do not apply fire-resistant material to metal roof deck substrates until roofing has been completed; prohibit roof traffic during application and drying of fire-resistant material.

5. Do not apply fire-resistant material to metal floor deck substrates until concrete topping has been completed.

6. Do not begin applying fire-resistant material until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.

7. Defer installing ducts, piping, and other items that would interfere with applying fire-resistant material until application of fire protection is completed.

8. Do not install enclosing or concealing construction until after fire-resistant material has been applied, inspected, and tested and corrections have been made to defective applications.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form, signed by Contractor and by Installer, in which manufacturer agrees to repair or replace SFRMs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Cracking, flaking, spalling, or eroding in excess of specified requirements; peeling; or delaminating of SFRM from substrates.
   b. Not covered under the warranty are failures due to damage by occupants and Owner's maintenance personnel, exposure to environmental conditions other than those investigated and approved during fire-response testing, and other causes not reasonably foreseeable under conditions of normal use.

2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Assemblies: Provide fireproofing, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.

B. Source Limitations: Obtain fireproofing for each fire-resistance design from single source.

C. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Steel members are to be considered unrestrained unless specifically noted otherwise.

D. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction[,] and the following VOC limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Primers, Sealers, and Undercoaters: 200 g/L.
4. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.

E. Low-Emitting Materials: Fireproofing used within the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Asbestos: Provide products containing no detectable asbestos.
2.2 CONCEALED SFRM

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   1. Concealed Cementitious SFRM:
      b. Isolatek International Corp.; Cafco 300.

B. Material Composition: Manufacturer's standard product, as follows:
   1. Concealed Cementitious SFRM: Factory-mixed, dry formulation of gypsum or portland cement binders, additives, and lightweight mineral or synthetic aggregates mixed with water at Project site to form a slurry or mortar for conveyance and application.

C. Physical Properties: Minimum values, unless otherwise indicated, or higher values required to attain designated fire-resistance ratings, measured per standard test methods referenced with each property as follows:
   1. Dry Density: 15 lb/cu. ft. for average and individual densities, or greater if required to attain fire-resistance ratings indicated, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method."
   2. Thickness: Minimum average thickness required for fire-resistance design indicated according to the following criteria, but not less than 0.375 inch, per ASTM E 605:
      a. Where the referenced fire-resistance design lists a thickness of 1 inch or more, the minimum allowable individual thickness of SFRM is the design thickness minus 0.25 inch.
      b. Where the referenced fire-resistance design lists a thickness of less than 1 inch but more than 0.375 inch, the minimum allowable individual thickness of SFRM is the greater of 0.375 inch or 75 percent of the design thickness.
      c. No reduction in average thickness is permitted for those fire-resistance designs whose fire-resistance ratings were established at densities of less than 15 lb/cu. ft.
   3. Bond Strength: 150 lbf/sq. ft. minimum per ASTM E 736 based on laboratory testing of 0.75-inch minimum thickness of SFRM.
   4. Compressive Strength: 5.21 lbf/sq. in. minimum per ASTM E 761. Minimum thickness of SFRM tested shall be 0.75 inch and minimum dry density shall be as specified but not less than 15 lb/cu. ft.
   6. Deflection: No cracking, spalling, or delamination per ASTM E 759.
   7. Effect of Impact on Bonding: No cracking, spalling, or delamination per ASTM E 760.
   8. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. in 24 hours per ASTM E 859. For laboratory tests, minimum thickness of SFRM is 0.75 inch, maximum dry density is 15 lb/cu. ft., test specimens are not prepurged by mechanically induced air velocities, and tests are terminated after 24 hours.
   9. Fire-Test-Response Characteristics: Provide SFRM with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
      a. Flame-Spread Index: 0.
      b. Smoke-Developed Index: 0.
   10. Fungal Resistance: No observed growth on specimens per ASTM G 21.

2.3 EXPOSED SFRM

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   1. Exposed Cementitious SFRM:
      b. Isolatek International Corp.; Cafco 400.

B. Material Composition: Manufacturer's standard product, as follows:
1. Exposed Cementitious SFRM: Factory-mixed, dry, cement aggregate formulation; or chloride-free formulation of gypsum or portland cement binders, additives, and inorganic aggregates mixed with water at Project site to form a slurry or mortar for conveyance and application.

C. Physical Properties: Minimum values, unless otherwise indicated, or higher values required to attain designated fire-resistance ratings, measured per standard test methods referenced with each property as follows:
   1. Dry Density: Values for average and individual densities as required for fire-resistance ratings indicated, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method," but with an average density of not less than 22 lb/cu. ft.
   2. Bond Strength: 434 lbf/sq. ft. minimum per ASTM E 736.
   3. Compressive Strength: 51 lbf/sq. in. minimum per ASTM E 761.
   5. Deflection: No cracking, spalling, or delamination per ASTM E 759.
   6. Effect of Impact on Bonding: No cracking, spalling, or delamination per ASTM E 760.
   7. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. per ASTM E 859.
   9. Fire-Test-Response Characteristics: Provide SFRM with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
      a. Flame-Spread Index: 0.
      b. Smoke-Developed Index: 0.
   10. Fungal Resistance: No observed growth on specimens per ASTM G 21.

2.4 EXPOSED THIN FILM INTUMESCENT MASTIC FIRE-RESISTIVE COATINGS

A. Basis-of-Design Product: Subject to compliance with requirements, provide “A/D Firefilm III” and “Carbocrylic 3350” topcoat, as manufactured by Carboline, or a comparable product.

B. Thin Film Fire-Resistant, Intumescent Mastic Coating: Factory-mixed formulation.
   1. Water-Based Formulation: Approved by manufacturer and authorities having jurisdiction and investigated for Conditioned Interior Space Purpose by UL.
   2. Multicomponent system consisting of intumescent base coat and topcoat.

C. Color and Gloss: Match Architect’s sample.

D. Credit EQ 4.2: For field applications that are inside the weatherproofing system, use paints and coatings that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D:
   1. Flat Paints, Coatings, and Primers: VOC not more than 50 g/L.
   2. Nonflat Paints, Coatings, and Primers: VOC not more than 150 g/L.
   3. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.

E. Apply in thicknesses as required to achieve the required fire resistance rating indicated as recommended by the manufacturer, based on designs as tested by referenced testing agencies. If tests have not been performed on the actual steel shapes or sizes to be protected on this project, the manufacturer shall develop recommended thicknesses based on the test results that are available and their experience.

F. Color Top Coating: Subject to the fire resistive coating manufacturer’s confirmation that the color top coating materials are compatible with the fire-resistive mastic coating materials indicated, provide the manufacturer’s factory-formulated top color coat materials or the interior ferrous metal finish paint material as specified in Division 09 Section “Interior Painting.”
   1. Apply two coats in thicknesses indicated in Division 09 Section “Interior Painting,” except as otherwise recommended by the Thin Film Intumescent Mastic Fire Resistant Coating manufacturer to achieve the required fire resistance rating.
2.5 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that are compatible with fireproofing and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: Primers approved by fireproofing manufacturer and complying with one or both of the following requirements:
   1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
   2. Primer's bond strength in required fire-resistance design complies with specified bond strength for fireproofing and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E 736.

C. Bonding Agent: Product approved by fireproofing manufacturer and complying with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.

D. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required, according to fire-resistance designs indicated and fireproofing manufacturer's written recommendations. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive fireproofing.

E. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by fireproofing manufacturer.

F. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by fireproofing manufacturer. Include pins and attachment.

G. Sealer: Transparent-drying, water-dispersible, tinted protective coating recommended in writing by fireproofing manufacturer for each fire-resistance design.
   1. Product: Subject to compliance with requirements, provide "Cafco Bond-Seal" by Isolatek International.

H. Topcoat: Suitable for application over applied fireproofing; of type recommended in writing by fireproofing manufacturer for each fire-resistance design.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design. Verify compliance with the following:
   1. Substrates comply with requirements in the Section where the substrate and related materials and construction are specified.
   2. Substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, incompatible paints, incompatible encapsulants, or other foreign substances capable of impairing bond of fire-resistive materials with substrates under conditions of normal use or fire exposure.
   3. Objects penetrating fire-resistive material, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
4. Substrates are not obstructed by ducts, piping, equipment, and other suspended construction that will interfere with applying fire-resistive material.

5. Notify the Professional in writing of anticipated problems using the SFRM systems specified with substrates primed or furnished by others.

6. Submit written certification that the conditions and substrates are acceptable.

B. Verify that concrete work on steel deck has been completed before beginning fireproofing work.

C. Verify that roof construction, installation of roof-top HVAC equipment, and other related work is complete before beginning fireproofing work.

D. Conduct tests according to fireproofing manufacturer's written recommendations to verify that substrates are free of substances capable of interfering with bond.

E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Remove accessories, plates, machined surfaces, lighting fixtures, and similar items that are not to be coated, or provide surface-applied protection prior to surface preparation and coating. Remove these items, if necessary, to completely coat the items to be fireproofed. Mask off or otherwise protect items and adjacent surfaces (including the adjacent metal decking) that are not to be fireproofed. Following completion of coating operations in each space or area, reinstall items removed, using workers skilled in the trades involved.

B. Clean substrates of substances that could impair bond of fire-resistive material, including dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, and incompatible primers, paints, and encapsulants.

C. Schedule cleaning and coating application so dust and other contaminants will not fall on wet, newly coated surfaces.

D. Surface Preparation: Clean and prepare surfaces to be coated according to the manufacturer's instructions for the particular substrate conditions, and as specified. Surfaces to be coated must be free of oil, grease, dirt, rust, and loose or powdery paint. Comply with the surface preparation requirements specified in Division 09 Section, “Interior Painting”.
   1. Touch-up shop applied prime coats which have been damaged, and bare areas. Wire-brush, solvent clean, and touch-up with the same primer as the shop coat.
   2. Bonding Agent: If required, apply bonding agent to surfaces in accordance with the manufacturer's instructions for the type of substrate and application required.

E. Material Preparation: Carefully mix and prepare materials in accordance with the coating manufacturer's directions.
   1. Stir materials before application to produce a mixture of uniform density, and as required during application. Do not stir surface film into the material. Remove film and strain material before using.
   2. If the manufacturer permits thinning, use only thinners recommended by the manufacturer, and only within recommended limits.

F. Prime substrates where recommended in writing by SFRM manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive SFRM.

G. For exposed applications, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of SFRM. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.
3.3 APPLICATION, GENERAL

A. Comply with fire-resistive material manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and spray on fire-resistive material, as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

B. Apply SFRM that is identical to products tested as specified in Part 1 "Quality Assurance" Article and substantiated by test reports, with respect to rate of application, accelerator use, sealers, topcoats, tamping, troweling, water overspray, or other materials and procedures affecting test results.

C. Install metal lath and reinforcing fabric, as required, to comply with fire-resistance ratings and fire-resistive material manufacturer's written recommendations for conditions of exposure and intended use. Securely attach lath and fabric to substrate in position required for support and reinforcement of fire-resistive material. Use anchorage devices of type recommended in writing by SFRM manufacturer. Attach accessories where indicated or required for secure attachment of lath and fabric to substrate.

D. Coat substrates with bonding adhesive before applying fire-resistive material where required to achieve fire-resistance rating or as recommended in writing by SFRM manufacturer for material and application indicated.

E. Extend fire-resistive material in full thickness over entire area of each substrate to be protected. Unless otherwise recommended in writing by SFRM manufacturer, install body of fire-resistive covering in a single course.

F. Spray apply fire-resistive materials to maximum extent possible, unless indicated otherwise below. Following the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by SFRM manufacturer.

G. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply SFRM that differs in color from that of encapsulant over which it is applied.

H. Where sealers are used, apply products that are tinted to differentiate them from SFRM over which they are applied.

3.4 APPLICATION, CONCEALED SFRM

A. Apply concealed SFRM in thicknesses and densities not less than those required to achieve fire-resistance ratings designated for each condition, but apply in greater thicknesses and densities if specified in Part 2 "Concealed SFRM" Article.

B. Apply water overspray to concealed sprayed-fiber fire-resistive material as required to obtain designated fire-resistance rating.

C. Cure concealed SFRM according to product manufacturer's written recommendations.

D. Apply sealer to concealed SFRM where required.

E. Apply topcoat to concealed SFRM where indicated.

3.5 APPLICATION, EXPOSED SFRM

A. Apply exposed SFRM in thicknesses and densities not less than those required to achieve fire-resistance ratings designated for each condition, but apply in greater thicknesses and densities if indicated.
1. For steel beams and bracing, provide a thickness of not less than 1 inch.
2. For metal floor or roof decks, provide a thickness of not less than 1/2 inch.

B. Provide a uniform finish complying with description indicated for each type of material and matching Architect's sample or, if none, finish approved for field-erected mockup.

C. Apply exposed cementitious SFRM to produce the following finish:
   1. Skip-troweled finish with leveled surface, smoothed-out texture, and neat edges.

D. Cure exposed SFRM according to product manufacturer's written recommendations.

E. Apply tinted topcoat to SFRM where indicated for a painted finish.

3.6 FIELD QUALITY CONTROL

A. Retain first option in paragraph below if Owner engages special inspector. If authorities having jurisdiction permit Contractor to engage special inspector, retain second option and retain option for submitting special inspection reports in "Submittals" Article.

B. Retain first option in first paragraph below if Owner engages testing agency. If authorities having jurisdiction permit Contractor to engage testing agency, retain second option and retain option for submitting field quality-control reports in "Submittals" Article.

C. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and prepare test reports.
   1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

D. Tests and Inspections: Testing and inspecting of completed applications of SFRM shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with application of SFRM for the next area until test results for previously completed applications of SFRM show compliance with requirements. Tested values must equal or exceed values indicated and required for approved fire-resistance design.
   1. Thickness for Floor, Roof, and Wall Assemblies: For each 1000-sq. ft. area, or partial area, on each floor, from the average of 4 measurements from a 144-sq. in. sample area, with sample width of not less than 6 inches per ASTM E 605.
   2. Thickness for Structural Frame Members: From a sample of 25 percent of structural members per floor, taking 9 measurements at a single cross section for structural frame beams or girders, 7 measurements of a single cross section for joists and trusses, and 12 measurements of a single cross section for columns per ASTM E 605.
   3. Density for Floors, Roofs, Walls, and Structural Frame Members: At frequency and from sample size indicated for determining thickness of each type of construction and structural framing member, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method."
   4. Bond Strength for Floors, Roofs, Walls, and Structural Framing Members: For each 10,000-sq. ft. area, or partial area, on each floor, cohesion and adhesion from one sample of size indicated for determining thickness of each type of construction and structural framing member, per ASTM E 736.
      a. Field test SFRM that is applied to flanges of wide-flange, structural-steel members on surfaces matching those that will exist for remainder of steel receiving fire-resistive material.
      b. If surfaces of structural steel receiving SFRM are primed or otherwise painted for coating materials, perform series of bond tests specified in UL's "Fire Resistance Directory." Provide bond strength indicated in referenced UL fire-resistance criteria, but not less than 150 lbf/sq. ft. minimum per ASTM E 736.
5. If testing finds applications of SFRM are not in compliance with requirements, testing and inspecting agency will perform additional random testing to determine extent of noncompliance.

E. Remove and replace applications of SFRM that do not pass tests and inspections for cohesion and adhesion, for density, or for both and retest as specified above.

F. Apply additional SFRM, per manufacturer's written instructions, where test results indicate that thickness does not comply with specified requirements, and retest as specified above.

3.7 CLEANING, PROTECTING, AND REPAIRING

A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

B. Protect fireproofing, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fireproofing will be without damage or deterioration at time of Substantial Completion.

C. Coordinate application of SFRM with other construction to minimize need to cut or remove fire protection. As installation of other construction proceeds, inspect fireproofing and repair damaged areas and fireproofing removed due to work of other trades.

D. Repair fireproofing damaged by other work before concealing it with other construction.

E. Repair fireproofing by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

3.8 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 07 81 00
SECTION 07 84 13 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Penetrations in fire-resistance-rated walls.
   2. Penetrations in horizontal assemblies.

B. Related Sections:
   1. Division 07 Section "Fire-Resistive Joint Systems" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.
   2. Division 21 Sections for firestopping requirements associated with HVAC construction.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For penetration firestopping sealants and sealant primers, documentation including printed statement of VOC content.

C. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.
   1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.
1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Penetration firestopping is identical to those tested per testing standard referenced in “Penetration Firestopping” Article. Provide rated systems complying with the following requirements:
   a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
   b. Classification markings on penetration firestopping correspond to designations listed by agencies acceptable to authorities having jurisdiction.

C. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

C. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by Owner’s inspecting agency and building inspector, if required by authorities having jurisdiction.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Grace Construction Products.
3. Hilti, Inc.
5. NUCO Inc.
6. RectorSeal Corporation.
7. Specified Technologies Inc.
8. 3M Fire Protection Products.
10. USG Corporation.

2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. Fire-resistance-rated walls include fire walls fire-barrier walls smoke-barrier walls and fire partitions.
2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. Horizontal assemblies include floors floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.
2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

E. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:
   a. Slag-wool-fiber or rock-wool-fiber insulation.
   b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
   c. Fire-rated form board.
   d. Fillers for sealants.

2. Temporary forming materials.
5. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for fire stopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove
damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

3.7 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 07 84 13
SECTION 07 84 46 - FIRE-RESISTIVE JOINT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Joints in or between fire-resistance-rated constructions.
      2. Joints at exterior curtain-wall/floor intersections.
   B. Related Sections:
      1. Division 07 Section "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. LEED Submittals:
      1. Product Data for Credit IEQ 4.1: For fire-resistive joint system sealants, documentation including printed statement of VOC content.
   C. Product Schedule: For each fire-resistive joint system. Include location and design designation of qualified testing agency.
      1. Where Project conditions require modification to a qualified testing agency's illustration for a particular fire-resistive joint system condition, submit illustration, with modifications marked, approved by fire-resistive joint system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For qualified Installer.
   B. Installer Certificates: From Installer indicating fire-resistive joint systems have been installed in compliance with requirements and manufacturer's written recommendations.
   C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.

1.5 QUALITY ASSURANCE
   A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."
   B. Fire-Test-Response Characteristics: Fire-resistive joint systems shall comply with the following requirements:
      1. Fire-resistive joint system tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Fire-resistive joint systems are identical to those tested per testing standard referenced in "Fire-Resistive Joint Systems" Article. Provide rated systems complying with the following requirements:
   a. Fire-resistive joint system products bear classification marking of qualified testing agency.
   b. Fire-resistive joint systems correspond to those indicated by reference to designations listed by the following:
      1) UL in its "Fire Resistance Directory."

C. Preinstallation Conference: Conduct conference at Project site.

1.6 Project Conditions

A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure fire-resistive joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.7 Coordination

A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

C. Notify Owner's testing agency at least seven days in advance of fire-resistive joint system installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 Fire-Resistive Joint Systems

A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:
   1. Joints include those installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies.
   2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
   3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. CEMCO.
      c. Fire Trak Corp.
      d. Grace Construction Products.
      e. Hilti, Inc.
      f. Johns Manville.
      g. Nelson Firestop Products.
      h. NUCO Inc.
j. RectorSeal Corporation.
k. Specified Technologies Inc.
l. 3M Fire Protection Products.
n. USG Corporation.

C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide fire-resistant joint systems with rating determined by ASTM E 119 based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa) or ASTM E 2307.
   1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Grace Construction Products.
      c. Hilti, Inc.
      d. Johns Manville.
      e. Nelson Firestop Products.
      f. NUCO Inc.
      g. Passive Fire Protection Partners.
      h. RectorSeal Corporation.
      i. Specified Technologies Inc.
      j. 3M Fire Protection Products.
      k. Thermafiber, Inc.
      m. USG Corporation.

D. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

E. VOC Content: Fire-resistive joint system sealants shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1. Architectural Sealants: 250 g/L.
   2. Sealant Primers for Nonporous Substrates: 250 g/L.
   3. Sealant Primers for Porous Substrates: 775 g/L.

F. Accessories: Provide components of fire-resistant joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistant joint system manufacturer and approved by the qualified testing agency for systems indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean joints immediately before installing fire-resistant joint systems to comply with fire-resistant joint system manufacturer's written instructions and the following requirements:
1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

3.3 INSTALLATION

A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
   1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:
   1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
   2. Apply fill materials so they contact and adhere to substrates formed by joints.
   3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
   2. Contractor's name, address, and phone number.
   3. Designation of applicable testing agency.
   4. Date of installation.
   5. Manufacturer's name.
   6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or fire-resistive joint systems are damaged or removed due to testing, repair or replace fire-resistive joint systems so they comply with requirements.
C. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

3.7 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 07 84 46
SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions
and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Silicone joint sealants.
   2. Urethane joint sealants.
   3. Latex joint sealants.
   4. Preformed joint sealants.
   5. Acoustical sealants.

B. Related Sections: Sealant work related to the work specified in the following Sections is work of the
following Sections but shall also comply with the requirements of this Section. The additional
requirements specified under this section include, but are not limited to, pre-construction
compatibility and adhesion testing and installation with work specified in the following Sections:
   1. Division 04 Section "Unit Masonry" for masonry control and expansion joint fillers and
gaskets.
   2. Division 07 Section "Fire-Resistant Joint Systems" for sealing joints in fire-resistance-rated
construction.
   3. Division 07 Section “Fluid Applied Air and Vapor Barrier” for sealant joints within and between
the air and vapor barrier system and adjacent construction.
   4. Division 07 Section “EPDM Roofing” for sealant joints integrated within roofing system.
   5. Division 07 Section “Garden Roof” for sealant joints integrated within roofing system.
   6. Division 08 Section "Glazed Aluminum Curtain Walls" for structural and other glazing
sealants.
   7. Division 08 Section "Glazing" for glazing sealants.
   8. Division 09 Section "Gypsum Board" for sealing perimeter joints and acoustical sealant when
associated with gwb partitions, ceilings, etc.
   9. Division 09 Section "Tiling" for sealing tile joints.
  10. Division 09 Section "Acoustical Panel Ceilings" for sealing edge moldings at perimeters with
acoustical sealant.

1.3 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for
testing indicated below, samples of materials that will contact or affect joint sealants.
   1. Use ASTM C 1087 to determine whether priming and other specific joint preparation
techniques are required to obtain rapid, optimum adhesion of joint sealants to joint
substrates.
   2. Submit not fewer than eight pieces of each kind of material, including joint substrates, shims,
joint-sealant backings, secondary seals, and miscellaneous materials.
   3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for
corrective measures including use of specially formulated primers.
   5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that
are based on previous testing, not older than 24 months, of sealant products for adhesion to,
and compatibility with, joint substrates and other materials matching those submitted.
B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each application indicated below:
   a. Each kind of sealant and joint substrate indicated.
3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
      1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.4 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For sealants and sealant primers used inside the weatherproofing system, documentation including printed statement of VOC content.

C. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

D. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

E. Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

C. Sealant, Waterproofing, and Restoration Institute (SWRI) Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.

E. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

F. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

G. Field-Adhesion Test Reports: For each sealant application tested.

H. Warranties: Sample of special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency.
1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
2. Test according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.

D. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

E. Preinstallation Conference: Conduct conference at Project site.

1.7 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Ten years from date of Substantial Completion.
C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from natural causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Architectural Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.

D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

E. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

F. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range of standard and premium colors.

2.2 SILICONE JOINT SEALANTS

A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Tremco Incorporated; Spectrem 1.

2.3 URETHANE JOINT SEALANTS

A. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Sika Corporation, Construction Products Division; Sikaflex - 15LM.
   b. Tremco Incorporated; Dymonic FC.

B. Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Tremco Incorporated; Vulkem 45.

C. Multipart, Pourable Urethane Sealant for Use T: ASTM C 920; Type M; Grade P; Class 25; Uses T, M, A, and, as applicable to joint substrates indicated, O.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Tremco Incorporated.; THC-900, THC-901 or Vulkem 245.

2.4 LATEX JOINT SEALANTS

A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Tremco Incorporated; Tremflex 834.

2.5 PREFORMED JOINT SEALANTS

A. Preformed Foam Joint Sealant: Manufacturer's standard preformed, precompressed, open-cell foam sealant manufactured from urethane foam with minimum density of 10 lb/cu. ft. (160 kg/cu. m) and impregnated with a nondrying, water-repellent agent. Factory produce in precompressed sizes in roll or stick form to fit joint widths indicated; coated on one side with a pressure-sensitive adhesive and covered with protective wrapping.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Dayton Superior Specialty Chemicals; Polytite Standard.
      b. EMSEAL Joint Systems, Ltd.; Emseal 25V.
      c. Sandell Manufacturing Co., Inc.; Polyseal.
      d. Willseal USA, LLC; Willseal 150 or Willseal 250.

2.6 ACOUSTICAL JOINT SEALANTS

A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Pecora Corporation; AC-20 FTR.
      b. USG Corporation; SHEETROCK Acoustical Sealant.

2.7 JOINT SEALANT BACKING

A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size...
and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.8 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
   a. Concrete.
   b. Brick, Stone and CMU Masonry.
   c. Unglazed surfaces of ceramic tile.

3. Remove laitance and form-release agents from concrete.

4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
   a. Metal
   b. Primed and/or painted steel
   c. Primed and/or painted aluminum
   d. Fluoropolymer coated aluminum
   e. Zinc coated copper flashing and trim.
f. Glass.
g. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
   4. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.
   5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
      a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

G. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping. Do not pull or stretch material. Produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures, apply heat to sealant in compliance with sealant manufacturer's written instructions.
H. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
1. Extent of Testing: Test completed and cured sealant joints as follows:
   a. Perform [10] tests for the first 1000 feet (300 m) of joint length for each kind of sealant and joint substrate.
   b. Perform 1 test for each 1000 feet (300 m) of joint length thereafter or 1 test per each floor per elevation.
   a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
3. Inspect tested joints and report on the following:
   a. Whether sealants filled joint cavities and are free of voids.
   b. Whether sealant dimensions and configurations comply with specified requirements.
   c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
1. Joint Locations:
   a. Control and expansion joints in stone and flooring, including steps.
b. Isolation and contraction joints in cast-in-place concrete slabs.
c. Tile control and expansion joints.
d. Joints between different materials listed above.
e. Other joints as indicated.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

   1. Joint Locations:
      b. Control and expansion joints in unit masonry.
      c. Joints in dimension stone cladding.
      d. Joints between metal panels.
      e. Joints between different materials listed above.
      f. Zinc-faced copper flashing and trim.
      g. Perimeter joints between materials listed above and frames of doors, windows and louvers.
      h. Control and expansion joints in ceilings and other overhead surfaces.
      i. Other joints as indicated.
   2. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 100/50.

C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
   1. Joint Locations:
      b. Control and expansion joints in stone flooring.
      c. Control and expansion joints in tile flooring.
      d. Other joints as indicated.
   2. Urethane Joint Sealant: Multi component, pourable, traffic grade.

   1. Joint Locations:
      a. Control and expansion joints on exposed interior surfaces of exterior walls.
      b. Perimeter joints of exterior openings where indicated.
      c. Tile control and expansion joints.
      d. Vertical joints on exposed surfaces of interior unit masonry, concrete walls and partitions.
      e. Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.
      f. Other joints as indicated.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

E. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces.
   1. Joint Location:
      a. Acoustical joints where indicated.
      b. Other joints as indicated.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

3.8 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 07 92 00
SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Standard hollow metal doors and frames.

B. Related Sections:
   1. Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
   2. Division 08 Section "Door Hardware" for door hardware for hollow metal doors.
   3. Division 09 Section "Painting" for field painting hollow metal doors and frames.
   4. Division 26 Sections for electrical connections including conduit and wiring for door controls and operators.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

C. Custom Hollow Metal Work: Hollow metal work fabricated according to ANSI/NAAMM-HMMA 861.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, and finishes.

B. Shop Drawings: Include the following:
   1. Elevations of each door design.
   2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
   3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   4. Locations of reinforcement and preparations for hardware.
   5. Details of each different wall opening condition.
   6. Details of anchorages, joints, field splices, and connections.
   7. Details of accessories.
   8. Details of moldings, removable stops, and glazing.
   9. Details of conduit and preparations for power, signal, and control systems.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification:
   1. For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (75 by 125 mm).

E. Other Action Submittals:
1. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.

1.5 INFORMATIONAL SUBMITTALS
A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

1.6 QUALITY ASSURANCE
A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.
B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252.
C. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784.
D. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
1. Provide additional protection to prevent damage to finish of factory-finished units.
2. Minimize packaging required for material delivery to the extent possible without compromising protection of materials while either in transit to the project site or being stored on site. Refer to Construction Waste Management Plan.
B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch- (102-mm-) high wood blocking. Do not store in a manner that traps excess humidity.
1. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

1.8 PROJECT CONDITIONS
A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.9 COORDINATION
A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum A40 (ZF120) metallic coating.

D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.
   1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.

G. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. (96- to 192-kg/cu. m) density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

H. Glazing: Comply with requirements in Division 08 Section "Glazing."

I. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD HOLLOW METAL DOORS

A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.
   1. Design: Flush panel.
   2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
      a. Fire Door Core: As required to provide fire-protection ratings indicated.
b. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W) when tested according to ASTM C 1363.
   1) Locations: Exterior doors.
3. Vertical Edges for Single-Acting Doors: Square edge unless beveled edge is indicated.
   a. Beveled Edge: 1/8 inch in 2 inches (3 mm in 50 mm).
4. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch (54-mm) radius.
5. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- (1.0-mm-) thick, end closures or channels of same material as face sheets.

B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
   1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush).

C. Interior Doors: Face sheets fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
   1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush).

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
E. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.4 STANDARD HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.
   1. Fabricate frames with mitered or coped corners.
   2. Fabricate frames as face welded unless otherwise indicated.
   3. Frames for Level 3 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
C. Interior Frames: Fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated.
   1. Fabricate frames with mitered or coped corners.
   2. Fabricate frames as face welded unless otherwise indicated.
   3. Fabricate knocked-down, drywall slip-on frames for in-place gypsum board partitions.
   4. Frames for Level 3 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
   5. Frames for Wood Doors: 0.067-inch- (1.7-mm-) thick steel sheet.
   6. Frames for Borrowed Lights: Same as adjacent door frame.
D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

A. Jamb Anchors:
   1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2 inches (50 mm) wide by 10 inches (250 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.
   2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch (1.0 mm) thick.
B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch (1.0 mm) thick, and as follows:
   1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
   2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch (50-mm) height adjustment. Terminate bottom of frames at finish floor surface.
   3. Access Floor: Comply with all access flooring manufacturer's requirements and recommendations for anchoring construction to and near access flooring.

2.6 HOLLOW METAL PANELS

A. Provide hollow metal panels of same materials, construction, and finish as specified for adjoining hollow metal work.

2.7 STOPS AND MOLDINGS

A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch (0.8 mm) thick, fabricated from same material as door face sheet in which they are installed.

B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated.

C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch (0.8 mm) thick, fabricated from same material as frames in which they are installed.

2.8 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch- (6.4-mm-thick by 25.4-mm-) wide steel.

C. Grout Guards: Formed from same material as frames, not less than 0.016 inch (0.4 mm) thick.

2.9 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

C. Hollow Metal Doors:
   1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
   2. Glazed Lites: Factory cut openings in doors.
   3. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted.

D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
   1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
2. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.

3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.

5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.

6. Jamb Anchors: Provide number and spacing of anchors as follows:
   a. Masonry Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
      1) Two anchors per jamb up to 60 inches (1524 mm) high.
      2) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
      3) Four anchors per jamb from 90 to 120 inches (2286 to 3048 mm) high.
      4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 120 inches (3048 mm) high.
   b. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
      1) Three anchors per jamb up to 60 inches (1524 mm) high.
      2) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
      3) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
      4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.
      5) Two anchors per head for frames above 42 inches (1066 mm) wide and mounted in metal-stud partitions.
   c. Compression Type: Not less than two anchors in each jamb.
   d. Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.

7. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.
   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
   b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
   1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
   2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
   3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
   4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

G. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
   1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
   2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
   3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
   4. Provide loose stops and moldings on inside of hollow metal work.
5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.10 STEEL FINISHES

A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
   1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:
   1. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   2. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
   3. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   4. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.
   1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
      a. At fire-protection-rated openings, install frames according to NFPA 80.
b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.

c. Install frames with removable glazing stops located on secure side of opening.

d. Install door silencers in frames before grouting.

e. Remove temporary braces necessary for installation only after frames have been properly set and secured.

f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

g. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.

a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.


4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.

5. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.

6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

7. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.

8. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

   a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   
   b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
   
   c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   
   d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:

   a. Jambs and Head: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
   
   b. Between Edges of Pairs of Doors: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
   
   c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch (9.5 mm).
   
   d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch (19 mm).

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

D. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (50 mm) o.c. from each corner.
3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

D. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer’s written instructions.

3.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

END OF SECTION 08 11 13
SECTION 08 12 16 – INTERIOR ALUMINUM FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes interior aluminum frames for doors and glazing installed in gypsum board partitions.

B. Related Sections:
   1. Division 08 Section "Flush Wood Doors" for wood doors installed in interior aluminum frames.
   2. Division 08 Section "Stile and Rail Wood Doors" for wood doors installed in interior aluminum frames.
   3. Division 26 Sections for electrical connections including conduit and wiring for door controls and operators.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, fire-resistance rating, and finishes.

B. Shop Drawings: Include the following:
   1. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   2. Locations of reinforcements and preparations for hardware.
   3. Details of each different wall-opening condition.
   4. Details of anchorages, joints, field splices, and connections.
   5. Details of accessories.
   6. Details of moldings, removable stops, and glazing.
   7. Details of conduits and preparations for power, signal, and control systems.

C. Samples for Initial Selection: For units with factory-applied finishes.
   1. Include similar Samples of seals, gaskets, and accessories involving color selection.

D. Samples for Verification: For interior aluminum frames, prepared on Samples of size indicated below:
   1. Framing Member: 12 inches (300 mm) long.
   2. Corner Fabrication: 12-by-12-inch- (300-by-300-mm-) long, full-size window corner, including full-size sections of extrusions with factory-applied color finish.

E. Schedule: For interior aluminum frames. Use same designations indicated on Drawings. Coordinate with door hardware schedule and glazing.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of interior aluminum frame.
1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For interior aluminum frames to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain interior aluminum frames from single source from single manufacturer.

B. Installer Qualifications: An experienced installer who has completed systems similar in material, design, and extent to that indicated for Project and whose work has resulted in construction with a record of successful in-service performance.

C. Fire-Rated Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

D. Preinstallation Conference: Conduct conference at Project site.

1.7 WARRANTY

A. Provide manufacturer’s product warranty of one (1) year.

B. Provide paint finish warranty of five (5) years.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver interior aluminum frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic. Store interior aluminum frames under cover at Project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide “Solutions II” Series, 1-1/2” profile, as manufactured by RACO Interior Products, Inc., or comparable product by one of the following:
1. Advanced Architectural Frames.
2. Custom Components Company.
4. Frameworks Manufacturing.
5. Interior Components Inc.
6. Modulex, Inc; Division of Pacific National Group.
7. RACO Interior Products, Inc.
8. Versatrac.
9. Western Integrated Materials, Inc.

2.2 COMPONENTS

A. Aluminum Framing: ASTM B 221 (ASTM B 221M), Alloy 6063-T5 or alloy and temper required to suit structural and finish requirements, not less than 0.062 inch (1.6 mm) thick.

B. Door Frames: Extruded aluminum, reinforced for hinges, strikes, and closers.
1. 90-Minute Fire-Protection Rating: Where indicated, fabricate aluminum frame assemblies with a cold-formed, primed, interior steel liner.

C. Glazing Frames: Extruded aluminum, for glazing thickness indicated.

D. Ceiling Tracks: Extruded aluminum.

E. Trim: Extruded aluminum, not less than 0.062 inch (1.6 mm) thick, with removable snap-in casing trim and glazing stops as indicated without exposed fasteners.
   1. Trim Style and Width: As indicated on Drawings.

2.3 ACCESSORIES

A. Fasteners: Aluminum, nonmagnetic, stainless-steel or other noncorrosive metal fasteners compatible with frames, stops, panels, reinforcement plates, hardware, anchors, and other items being fastened.

B. Door Silencers: Manufacturer's standard continuous mohair, wool pile, or vinyl seals; color to be selected by Architect.

C. Smoke Seals: Intumescent strip or fire-rated gaskets where required; color to be selected by Architect.

D. Glazing Gaskets: Manufacturer's standard extruded or molded plastic, to accommodate glazing thickness indicated; color to be selected by Architect.

E. Glazing: Comply with requirements in Division 08 Section "Glazing."

F. Hardware: Comply with requirements in Division 08 door hardware Sections.

2.4 FABRICATION

A. Provide concealed corner reinforcements and alignment clips for accurately fitted hairline joints at butted or mitered connections.

B. Factory prepare interior aluminum frames to receive templated mortised hardware; include cutouts, reinforcements, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
   1. Locate hardware as required by fire-rated label for assembly.

C. Fabricate frames for glazing with removable stops to allow glazing replacement without dismantling frame.
   1. Locate removable stops on the inside of spaces accessed by keyed doors.

D. Fabricate components to allow secure installation without exposed fasteners.

2.5 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
2.6 ALUMINUM FINISHES

A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry-film thickness of 1.0 mils (0.025 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   2. Number of Colors: Three.
   3. Both solid and metallic colors will be used.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, and ceilings, with Installer present, for conditions affecting performance of the Work.
B. Verify that wall thickness does not exceed standard tolerances allowed by throat size indicated.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install interior aluminum frames plumb, rigid, properly aligned, and securely fastened in place; comply with manufacturer's written instructions.
B. Set frames accurately in position and plumbed, aligned, and securely anchored to substrates.
   1. At fire-protection-rated openings, install interior aluminum frames according to NFPA 80 and NFPA 105.
C. Install frame components in the longest possible lengths; components up to 9'-6" long must be one piece.
   1. Use concealed installation clips to produce tightly fitted and aligned splices and connections.
   2. Secure clips to extruded main-frame components and not to snap-in or trim members.
   3. Do not leave screws or other fasteners exposed to view when installation is complete.

3.3 CLEANING

A. Clean exposed frame surfaces promptly after installation, using cleaning methods recommended by frame manufacturer and according to AAMA 609 & 610.
B. Touch up marred frame surfaces so touchup is not visible. Remove and replace frames with damaged finish that cannot be satisfactorily repaired.

3.4 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
   1. Separate tempered glass waste for use as aggregate of nonstructural fill.
C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
1. Aluminum.
2. Plastic Materials
3. Corrugated cardboard packaging.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 08 12 16
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SECTION 08 14 16 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Solid-core doors with wood-veneer faces.
   2. Factory finishing flush wood doors with transparent finish.

B. Related Sections:
   1. Division 08 Section “Glazing” for glass view panels in flush wood doors.
   2. Division 08 Section “Steel Doors and Frames” for hollow metal frames for flush wood doors where indicated.
   3. Division 08 Section “Interior Aluminum Frames” for door frames to be used with flush wood doors.
   4. Division 08 Section “Door Hardware” for hardware required for flush wood doors.
   5. Division 08 Section “Stile and Rail Wood Doors” for stile and rail wood doors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of door indicated. Include details of core and edge construction, louvers, and trim for openings. Include factory-finishing specifications.

B. LEED Submittals:
   1. Certificates for Credit MR 7: Chain-of-custody certificates indicating that flush wood doors comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
   2. Product Data for Credit IEQ 4.4: For adhesives and composite wood products, documentation indicating that product contains no urea formaldehyde.

C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
   1. Indicate dimensions and locations of mortises and holes for hardware.
   2. Indicate dimensions and locations of cutouts.
   3. Indicate requirements for veneer matching.
   4. Indicate doors to be factory finished and finish requirements.
   5. Indicate fire-protection ratings for fire-rated doors.

D. Samples for Initial Selection: For factory-finished doors.

E. Samples for Verification:
   1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches (200 by 250 mm), for each material and finish. For each wood species and transparent finish, provide set of three samples showing typical range of color and grain to be expected in the finished work.
   2. Corner sections of doors, approximately 8 by 10 inches (200 by 250 mm), with door faces and edges representing actual materials to be used.
a. Provide samples for each species of veneer and solid lumber required.
b. Finish veneer-faced door samples with same materials proposed for factory-finished doors.

3. Louver blade and frame sections, 6 inches (150 mm) long, for each material and finish specified.

4. Frames for light openings, 6 inches (150 mm) long, for each material, type, and finish required.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Source Limitations: Obtain flush wood doors from single manufacturer.

C. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural Woodwork Quality Standards Illustrated."
   1. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.

D. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252.

E. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in plastic bags or cardboard cartons.

C. Minimize packaging required for door delivery without compromising protection of materials while either in transit to the project site or being stored on site. Refer to Construction Waste Management Plan.

D. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Warping (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section.
b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch (0.25 mm in a 76.2-mm) span.

2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.


PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Algoma Hardwoods, Inc.
2. Eggers Industries.
3. Graham; an Assa Abloy Group company.
4. Mohawk Flush Doors, Inc.; a Masonite company.
5. Oshkosh Architectural Door Company.

2.2 DOOR CONSTRUCTION, GENERAL

A. Certified Wood: Fabricate doors with all wood products produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

B. Low-Emitting Materials: Fabricate doors with adhesives and composite wood products that do not contain urea formaldehyde.

C. Particleboard-Core Doors:

1. Particleboard: ANSI A208.1, Grade LD-2, made with binder containing no urea-formaldehyde resin.
2. Alternate Particleboard: Straw-based particleboard complying with ANSI A208.1, Grade LD-2 or M-2, except for density.
3. Provide doors with either glued-wood-stave or structural-composite-lumber cores instead of particleboard cores for doors indicated to receive exit devices.

D. Structural-Composite-Lumber-Core Doors:

   a. Screw Withdrawal, Face: 700 lbf (3100 N).
   b. Screw Withdrawal, Edge: 400 lbf (1780 N).

E. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated.

1. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
2. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.

F. Mineral-Core Doors:

1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

2.3 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:
1. Grade: Premium, with Grade AA faces.
2. Species: Select cherry.
3. Cut: Plain sliced (flat sliced).
5. Assembly of Veneer Leaves on Door Faces: Balance match.
6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
7. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 20 feet (6 m) or more.
8. Transom Match: Continuous match.
10. Core: Particleboard unless noted otherwise.
11. Construction: Five or seven plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering.

2.4 LOUVERS AND LIGHT FRAMES

A. Wood Louvers: Door manufacturer's standard solid-wood louvers unless otherwise indicated.
   1. Wood Species: Same species as door faces.

B. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads as follows unless otherwise indicated.
   1. Wood Species: Same species as door faces.
   2. Profile: Flush rectangular beads unless noted otherwise.
   3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.

C. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.

2.5 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
   1. Comply with requirements in NFPA 80 for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
   1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
   2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

C. Openings: Cut and trim openings through doors in factory.
   1. Light Openings: Trim openings with moldings of material and profile indicated.
   2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Division 08 Section “Glazing.”
2.6 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
   1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.

B. Finish doors at factory that are indicated to receive transparent finish.

C. Transparent Finish:
   1. Grade: Premium.
   2. Finish: AWI catalyzed polyurethane system.
   4. Effect: Filled finish.
   5. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and installed door frames before hanging doors.
   1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
   2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Hardware: For installation, see Division 08 Section "Door Hardware."

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
   1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.

C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

3.4 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

END OF SECTION 08 14 16
SECTION 08 14 33 - STILE AND RAIL WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Interior stile and rail wood doors.
2. Factory finishing of stile and rail wood doors.
3. Fitting stile and rail wood doors to frames and machining for hardware.

B. Related Sections:
1. Division 06 Section "Interior Architectural Woodwork" for requirements for veneers from the same flitches for both architectural woodwork and stile and rail wood doors.
2. Division 08 Section "Glazing" for glass vision panels in stile and rail doors.
3. Division 08 Section "Aluminum Frames" for door frame assemblies for stile and rail wood doors fabricated from interior aluminum framing systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
1. Include details of construction and glazing.
2. Include factory finishing specifications.

B. LEED Submittals:
1. Certificates for Credit MR 7: Chain-of-custody certificates indicating that wood used for stile and rail wood doors complies with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
2. Product Data for Credit IEQ 4.4: For adhesives and composite wood materials, documentation indicating that products contain no urea formaldehyde.

C. Shop Drawings: For stile and rail wood doors. Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data, including those for stiles, rails, panels, and moldings (sticking); and other pertinent data, including the following:
1. Dimensions of doors for factory fitting.
2. Locations and dimensions of mortises and holes for hardware.
3. Requirements for veneer matching.
4. Doors to be factory finished, and finish requirements.
5. Fire ratings for fire-rated doors.

D. Samples for Initial Selection (Consisting of color charts incorporating actual materials in small sections): For factory-finished doors, provide full range of standard and premium colors and finishes available for stained doors.

E. Samples for Verification: Corner sections of doors, approximately 8 by 10 inches (200 by 250 mm), with door faces and edgings representing typical range of color and grain for each species of veneer and solid lumber required. Finish Sample with same materials proposed for factory-finished doors.
1.4 INFORMATIONAL SUBMITTALS
   A. Product Certificates: For each type of door, from manufacturer.
   B. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE
   A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
   B. Source Limitations: Obtain stile and rail wood doors from single manufacturer.
   C. Safety Glass: Provide products complying with testing requirements in 16 CFR 1201, for Category II materials, unless those of Category I are expressly indicated and permitted.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Comply with manufacturer's written instructions and requirements of quality standard referenced in Part 2.
   B. Package doors individually in opaque plastic bags or cardboard cartons.
   C. Minimize packaging required for door delivery without compromising protection of materials while either in transit to the project site or being stored on site. Refer to Construction Waste Management Plan.
   D. Mark each door on top and bottom edge with opening number used on Shop Drawings.

1.7 PROJECT CONDITIONS
   A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.8 WARRANTY
   A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship, or have warped (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section.
      1. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
      2. Warranty shall be in effect during the following period of time from date of Substantial Completion:
         a. Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MATERIALS
   A. General: Use only materials that comply with referenced standards and other requirements specified.
1. Assemble interior doors, frames, and sidelites, including components, with either dry-use or wet-use adhesives complying with ASTM D 5572 for finger joints and with ASTM D 5751 for joints other than finger joints.

B. Certified Wood: Fabricate doors with all wood products produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

C. Low-Emitting Materials: Fabricate doors with adhesives and composite wood products that do not contain urea-formaldehyde resins.

2.2 INTERIOR STILE AND RAIL WOOD DOORS

A. Interior Stile and Rail Wood Doors: Custom interior doors complying with AWI's "Architectural Woodwork Quality Standards," and with other requirements specified.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Algoma Hardwoods, Inc.
   b. Eggers Industries.
   c. Enjo Architectural Millwork.
   d. Maiman Company (The).
   e. Pinecrest, Inc.
   f. Select Interior Door, Ltd.
   g. TruStile Doors LLC.
   h. Woodtech Trading Company.

2. Panel Designs: Indicated by Drawings. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

3. Grade: Premium.


5. Wood Species and Cut for Transparent Finish: Select clear cherry, plain sawed/sliced.

6. Door Construction for Transparent Finish:
   a. Stile and Rail Construction: Clear lumber; may be edge glued for width. Select lumber for similarity of grain and color, and arrange for optimum match between adjacent pieces.
   b. Thickness: As scheduled.

7. Stile and Rail Widths: As indicated.

8. Molding Profile (Sticking): Flat bead stop.

9. Glass: As indicated in door schedule, complying with Division 08 Section "Glazing."

10. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.

11. Finishing: Factory finish this door type according to finishing requirements in this Section.

2.3 STILE AND RAIL WOOD DOOR FABRICATION

A. Fabricate stile and rail wood doors in sizes indicated for field fitting.

B. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels unless otherwise indicated:

1. Clearances: Provide 1/8 inch (3 mm) at heads, jambs, and between pairs of doors. Provide 1/2 inch (13 mm) from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide not more than 3/8 inch (10 mm) from bottom of door to top of threshold.
   a. Comply with NFPA 80 for fire-rated doors.

2. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.

3. Bevel fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) on lock edge; trim stiles and rails only to extent permitted by labeling agency.
C. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W Series standards, and hardware templates.
   1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.

D. Glazed Openings: Trim openings indicated for glazing with solid wood moldings, with one side removable. Miter wood moldings at corner joints.

E. Glazed Openings: Glaze doors at factory with glass of type and thickness indicated, complying with Division 08 Section "Glazing." Install glass using manufacturer's standard elastomeric glazing sealant complying with ASTM C 920. Secure glass in place with removable wood moldings. Miter wood moldings at corner joints.

2.4 FINISHING

A. Finish wood doors at factory.

   1. Finish faces and all four edges of doors, including mortises and cutouts. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.

C. Transparent Finish:
   1. Grade: Premium.
   2. Finish: AWI catalyzed polyurethane system.
   4. Effect: Filled finish.
   5. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and substrates, with Installer present, for suitable conditions where wood stile and rail doors and fire-rated wood door frames will be installed.
   1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
   2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fire-rated wood door frames level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
   1. Countersink fasteners, fill surface flush, and sand smooth.

B. Hardware: For installation, see Division 08 Section "Door Hardware."

   1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
D. Field-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted with fire-rated doors. Machine doors for hardware. Seal cut surfaces after fitting and machining.
   1. Clearances: Provide 1/8 inch (3 mm) at heads, jambs, and between pairs of doors. Provide 1/2 inch (13 mm) from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide 3/8 inch (10 mm) from bottom of door to top of threshold.
      a. Comply with NFPA 80 for fire-rated doors.
   2. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.
   3. Bevel fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) on lock edge; trim stiles and rails only to extent permitted by labeling agency.

E. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

F. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

3.4 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

END OF SECTION 08 14 33
SECTION 08 31 13 - ACCESS DOORS AND FRAMES [C]

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Access doors and frames for walls and ceilings.

B. Related Requirements:
   1. Division 07 Section "Roof Accessories" for roof hatches.
   2. Division 08 Section "Door Hardware" for mortise or rim cylinder locks and master keying.
   3. Division 09 Section “Painting” for requirements for shop priming.
   4. Division 22 Section “Plumbing” for pipe and valve access doors.

1.3 ALLOWANCES

A. The General Trades Contractor should carry a $15,000 material allowance for access panels on this project and include labor for installation of 60 access panels. Once final quantities are determined the General Trades Contractor should provide the Construction Manager (3) proposals for the sizes and quantities needed. If the final cost of the access panels is lower than the allowance, a credit will be issued to the owner. The Owner reserves the right to supply the access panel for the project and recoup the entire allowance amount. [C]

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, fire ratings, materials, individual components and profiles, and finishes.

B. Shop Drawings:
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Detail fabrication and installation of access doors and frames for each type of substrate.

C. Samples: For each door face material, at least 3 by 5 inches (75 by 125 mm) in size, in specified finish.

D. Product Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics according to the following
test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.
2. NFPA 288 for fire-rated access door assemblies installed horizontally.

2.2 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Acudor Products, Inc.
2. Cendrex Inc.
3. Jensen Industries; Div. of Broan-Nutone, LLC.
7. Milcor Inc.
8. Nystrom, Inc.

B. Flush Access Doors with Concealed Flanges:
1. Assembly Description: Fabricate door to fit flush to frame. Provide frame with gypsum board or plaster beads for concealed flange installation.
2. Locations: Wall and ceiling.
3. Uncoated Steel Sheet for Door: Nominal 0.060 inch (1.52 mm), 16 gage.
4. Stainless-Steel Sheet for Door: Nominal 0.062 inch (1.59 mm), 16 gage.
   a. Finish: No. 4.
5. Frame Material: Same material and thickness as door.
7. Hardware: Cam latch operated by screwdriver with interior release.

C. Fire-Rated, Flush Access Doors with Concealed Flanges:
1. Assembly Description: Fabricate door to fit flush to frame, with a core of mineral-fiber insulation enclosed in sheet metal. Provide self-latching door with automatic closer and interior latch release. Provide frame with gypsum board or plaster beads for concealed flange installation.
2. Locations: Wall and ceiling.
3. Fire-Resistance Rating: Not less than that indicated.
4. Temperature-Rise Rating: 250 deg F (139 deg C) at the end of 30 minutes.
5. Uncoated Steel Sheet for Door: Nominal 0.036 inch (0.91 mm), 20 gage.
6. Stainless-Steel Sheet for Door: Nominal 0.038 inch (0.95 mm), 20 gage.
   a. Finish: No. 4.
7. Frame Material: Same material, thickness, and finish as door.
8. Hinges: Concealed pin type.
10. Lock: Self-latching device with cylinder lock.
    a. Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware."

2.3 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
C. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

E. Rolled-Stainless-Steel Floor Plate: ASTM A 793, manufacturer's standard finish.

F. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 316. Remove tool and die marks and stretch lines or blend into finish.

G. Frame Anchors: Same type as door face.

H. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

I. Drywall Beads: Edge trim formed from 0.0299-inch zinc-coated steel sheet formed to receive joint compound and in size to suit thickness of gypsum board.

J. Plaster Beads: Casing bead formed from 0.0299-inch zinc-coated steel sheet with flange formed out of expanded metal lath and in size to suit thickness of plaster.

2.4 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.
   1. For concealed flanges with drywall bead, provide edge trim for gypsum board and gypsum base securely attached to perimeter of frames.
   2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded metal lath and exposed casing bead welded to perimeter of frames.
   3. Provide mounting holes in frames for attachment of units to metal or wood framing.
   4. Provide mounting holes in frame for attachment of masonry anchors.

D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
   1. For cylinder locks, furnish two keys per lock and key all locks alike.

2.5 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Steel and Metallic-Coated-Steel Finishes:
1. Factory Prime: Apply manufacturer’s standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

E. Stainless-Steel Finishes:
   1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
   2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
      a. Run grain of directional finishes with long dimension of each piece.
      b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
      c. Directional Satin Finish: No. 4.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
   A. Comply with manufacturer's written instructions for installing access doors and frames.
   B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.3 ADJUSTING
   A. Adjust doors and hardware, after installation, for proper operation.
   B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

3.4 WASTE MANAGEMENT
   A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
   B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
      1. Aluminum.
      2. Plastic Materials
      3. Corrugated cardboard packaging.
   C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 08 31 13
SECTION 08 33 23 – ROLLING FIRE DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Fire-rated counter doors.
   2. Prefinished custom formed trim as shown in the Drawings.

B. Related Sections:
   1. Division 05 Section “Metal Fabrications” for miscellaneous steel supports.
   2. Division 09 Section “Interior Painting” for finish painting of factory-primed doors.
   3. Division 26 Sections for electrical service and connections for powered operators and accessories.

1.3 PERFORMANCE REQUIREMENTS

A. Provide doors with Underwriter’s Laboratories, Inc. label for the fire rating classification, 1-1/2 hr.

B. Provide doors with Underwriter’s Laboratories, Inc. label for “Leakage Rated Assembly” or ‘S’ label.
   1. Comply with NFPA 105 air leakage requirements.
   2. Pass UL test procedure 1784.

C. Seismic Performance: coiling doors shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
   2. Seismic Component Importance Factor: 1.25.

D. Operation Cycles: Provide overhead coiling door components and operators capable of operating for not less than number of cycles indicated for each door. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory. Include the following:
   1. Construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
   2. Rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
   3. For fire-rated doors, description of fire-release system including testing and resetting instructions.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Show locations of replaceable fusible links.
3. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.
   1. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
   2. Bottom Bar: 6 inches long.
   5. Hood: 6 inches square.
   6. Laminate-Clad Counter Panel Product: 6 inches square; for each type, color, pattern, and surface finish; laminated to core.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Seismic Qualification Certificates: For overhead coiling doors, accessories, and components, from manufacturer.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.

B. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.
   1. Obtain operators and controls from overhead coiling door manufacturer.
   2. Manufacturer shall be ISO 9001:2000 registered with a minimum of five years experience in producing counter fire doors of the type specified.

C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to UL 10B.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.


PART 2 - PRODUCTS
2.1 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
   1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural steel sheet; complying with ASTM A 653/A 653M, with G90 (Z275) zinc coating; nominal sheet thickness (coated) of 0.028 inch and as required to meet requirements.

B. Bottom Bar for Counter Doors: Manufacturer's standard continuous channel or tubular shape, fabricated from manufacturer's standard hot-dip galvanized steel, stainless steel, or aluminum extrusions to match curtain slats and finish.

C. Astragal for Interior Doors: Equip each door bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.

D. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

E. Custom Prefinished Formed Metal Trim: Formed of the same material and finish as curtain slats unless otherwise indicated. Manufacture and install cleats and finish trim as shown on the Drawings.

2.2 HOOD

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
   1. Galvanized Steel: Nominal 0.028-inch thick, hot-dip galvanized steel sheet with G90 (Z275) zinc coating, complying with ASTM A 653/A 653M.
   2. Include automatic drop baffle on fire-rated doors to guard against passage of smoke or flame.

2.3 COUNTER DOORS

A. Fire-Rated, Laminate Counter: Fire-door manufacturer's high-pressure decorative laminate-covered countertop, UL or ITS tested and labeled for 1-1/2-hour fire rating for approved use with fire-door assembly.

2.4 CURTAIN ACCESSORIES

A. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.
   1. Provide pull-down straps or pole hooks for doors more than 84 inches high.

B. Automatic-Closing Device for Fire-Rated Doors: Equip each fire-rated door with an automatic-closing device that is inoperative during normal door operations and that has a governor unit complying with NFPA 80 and an easily tested and reset release mechanism designed to be activated by the following:
   1. Replaceable fusible links with temperature rise and melting point of 165 deg F interconnected and mounted on both sides of door opening.
   2. Building fire-detection and -alarm systems and manufacturer's standard door-holder-release devices.
2.5 COUNTERBALANCING MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.

C. Spring Balance: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.6 MANUAL DOOR OPERATORS

A. Equip door with manufacturer's recommended manual door operator unless another type of door operator is indicated.

B. Push-up Door Operation: Design counterbalance mechanism so required lift or pull for door operation does not exceed 25 lbf.

2.7 FIRE-RATED DOOR ASSEMBLY

A. Fire-Rated Counter Door: Overhead fire-rated coiling door formed with curtain of interlocking metal slats.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Model ERC10 as manufactured by Cornell Iron Works, Inc., or comparable product by another manufacturer, including but not limited to one of the following:
      a. ACME Rolling Doors.
      b. Alpine Overhead Doors, Inc.
      c. Cornell Iron Works, Inc.

B. Operation Cycles: Not less than 20,000.

C. Fire Rating: 1-1/2 hours.

D. Door Curtain Material: Galvanized steel.

E. Door Curtain Slats: Flat profile slats of 1-1/2-inch center-to-center height.

F. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.

G. Hood: Match curtain material and finish.
   1. Shape: Square, As shown on Drawings.
   2. Mounting: As shown on Drawings.

H. Sill Configuration for Fire-Rated Counter Door: Fire-rated, laminate counter.
   1. High-Pressure Decorative Laminate: Match color, pattern, and finish of Architect's sample.

J. Door Finish:
   1. Baked-Enamel or Powder-Coated Finish: One color used, to be selected from manufacturer’s range of standard and premium colors.
   2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

2.8 GENERAL FINISH REQUIREMENTS

   A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

   B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 STEEL AND GALVANIZED-STEEL FINISHES

   A. Factory Prime Finish – Concealed Components: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

   B. Baked-Enamel or Powder-Coat Finish – on All Exposed Surfaces: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

   A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

   B. Examine locations of electrical connections.

   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

   A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

   B. Install overhead coiling doors, hoods, and operators at the mounting locations indicated for each door.

   C. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

   D. Fire-Rated Doors: Install according to NFPA 80.

3.3 STARTUP SERVICE

   A. Engage a factory-authorized service representative to perform startup service.
      1. Perform installation and startup checks according to manufacturer's written instructions.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Test door closing when activated by detector or alarm-connected fire-release system. Reset door-closing mechanism after successful test.

3.4 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
B. Lubricate bearings and sliding parts as recommended by manufacturer.
C. Adjust seals to provide weathertight fit around entire perimeter.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

3.6 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 08 33 23
SECTION 08 41 13 – ENTRANCE DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Exterior and interior manual-swing entrance doors and door-frame units.
   2. Fire stair exit door & frame.

B. Related Sections:
   1. Division 08 Section "Frameless Glass Doors & Storefronts" for systems without aluminum support framing.
   2. Division 08 Section “Door Hardware” for hardware to be installed on entrance and exit doors, and for automatic door operators.
   3. Division 08 Section “Glazing” for glazing to be stopped into entrance doors and frames.
   4. Division 08 Section "Glazed Aluminum Curtain Walls" for aluminum curtain wall assemblies, and for coordinating finishes among aluminum fenestration units.
   5. Division 08 Section "Aluminum Windows" for window mullion inserts set into aluminum doors, and for coordinating finishes among aluminum fenestration units.

1.3 DEFINITIONS

A. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Entrance doors and frames shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:

   1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
   2. Dimensional tolerances of building frame and other adjacent construction.
   3. Failure includes the following:
      a. Deflection exceeding specified limits.
      b. Thermal stresses transferring to building structure.
      c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
      d. Glazing-to-glazing contact.
e. Noise or vibration created by wind and by thermal and structural movements.
f. Loosening or weakening of fasteners, attachments, and other components.
g. Sealant failure.
h. Failure of operating units.

B. Structural Loads:
1. Wind Loads: As indicated on Drawings.
   a. Basic Wind Speed: As indicated on Drawings.
   b. Importance Factor: As indicated on Drawings.
   c. Exposure Category: As indicated on Drawings.

C. Thermal Movements: Provide aluminum entrance doors and frames that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
2. Interior Ambient-Air Temperature: 75 deg F.

D. Condensation Resistance for Thermally Broken Doors: Provide aluminum entrance doors and frames having condensation-resistance factor (CRF) of not less than 55 when tested according to AAMA 1503.

E. Thermal Conductance for Thermally Broken Doors: Provide aluminum entrance doors and frames having an average U-factor of not more than 0.48 Btu/sq. ft. x h x deg F when tested according to AAMA 1503.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for all systems.

B. LEED Submittals:
1. Product Data for Credit IEQ 4.1: For adhesives and sealants used inside of the weatherproofing system, documentation including printed statement of VOC content.

C. Shop Drawings: For all types of entrance doors and frames. Include plans, elevations, sections, details, and attachments to other work.
1. For entrance doors, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

F. Other Action Submittals:
1. Entrance Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and
diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

1.6 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified Installer.
B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency indicating compliance with performance requirements.
C. Source quality-control reports.
D. Warranties: Sample of special warranties.

1.7 CLOSEOUT SUBMITTALS
A. Maintenance Data: For entrance doors and frames to include in maintenance manuals.

1.8 QUALITY ASSURANCE
A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
B. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.
C. Accessible Entrances: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
D. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.
E. Preinstallation Conference: Conduct conference at Project site.

1.9 PROJECT CONDITIONS
A. Field Measurements: Verify actual locations of curtain wall openings into which entrance doors and frames are to be fitted by field measurements before fabrication and indicate measurements on Shop Drawings.
1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of entrance doors and frames that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including, but not limited to, excessive deflection.
   b. Noise or vibration caused by thermal movements.
   c. Deterioration of metals and other materials beyond normal weathering.
   d. Adhesive or cohesive sealant failures.
   e. Water leakage.
   f. Failure of operating components.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering.

1. Warranty Period: 20 years from date of Substantial Completion.

1.11 MAINTENANCE SERVICE

A. Entrance Door Hardware:

1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product for Thermally Broken Entrance Door and Frame: Subject to compliance with requirements, provide “ADS 65 HD” entrance doors as manufactured by Schüco International KG, or comparable product by one of the following:

1. EFCO Corporation.
2. Kawneer North America; an Alcoa company.
3. United States Aluminum.
4. Vistawall Architectural Products; The Vistawall Group; a Bluescope Steel company.
5. Schüco International KG

B. Basis-of-Design Product for Stainless Steel Entrance Door: Subject to compliance with requirements, provide doors by AMBICO Limited, 1120 Cummings Avenue, Ottawa, Ontario, Canada, K1J 7R8, 888-423-2224, or approved equal, as detailed in the Drawings.
2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
   4. Structural Profiles: ASTM B 308/B 308M.
   5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Stainless Steel: ASTM A240m type 304.

2.3 ALUMINUM ENTRANCE DOOR SYSTEMS

A. Aluminum Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.
   1. Door Construction: 2-1/2-inch overall thickness, with minimum 0.125-inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
      a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
   2. Door Design: Medium stile; 3-1/2-inch nominal width.
      a. Accessible Doors: Smooth surfaced for width of door in area within 10 inches above floor or ground plane.
      a. Provide nonremovable glazing stops on outside of door.
   4. Provide aluminum subframes for entrance doors where indicated or required at entrance doors installed in aluminum curtain wall assemblies.
   5. Provide 1” thick flat insulated panel set into stile and rail of aluminum door instead of glazing where indicated.
      a. Finish: to match door.
      b. Texture: Smooth; embossed panels will be rejected.

2.4 STAINLESS STEEL DOOR CONSTRUCTION

A. Door Core:
   1. Stiffened: Continuous vertical formed stainless steel sections, 0.026 in. minimum thickness, spaced with interior webs not more than 6 inches apart, which upon assembly, span the full thickness of the interior of the door. Voids between stiffeners shall be filled with fiberglass or mineral rock wool batt type material.
   2. Door Stiles: 4”, or as shown in Drawings.
   3. Door Rails: 6”, or as shown in Drawings.
   4. Face Thickness: 16 Gauge.
5. Construction: Butt seam door construction, longitudinal edges fully welded with no visible edge seam. Door panel will have visible face seams where stiles and rails intersect. Inverted, recessed, welded steel top and bottom steel channels.
6. Flush, stainless steel top caps on exterior doors.
7. Stainless steel hardware reinforcement plates welded in place.

2.5 ENTRANCE DOOR HARDWARE

A. General: Door manufacturer to provide entrance door hardware as indicated in this Section for each entrance door to comply with requirements of this Section.

B. Entrance Door Hardware by others: As specified in Division 08 Section “Door Hardware.”

C. Coordinate final entrance door hardware, whether provided by door manufacturer or others, with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

D. Weather Stripping: Manufacturer's standard replaceable components.
   1. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.
   2. Sliding Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

E. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.

2.6 ACCESSORY MATERIALS

A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 07 Section "Joint Sealants."
   1. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil thickness per coat.

2.7 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
4. Physical and thermal isolation of glazing from framing members.
5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
   1. At exterior doors, provide compression weather stripping at fixed stops.
   2. At interior vestibule doors, provide compression weather stripping at fixed stops.

E. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
   1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
   2. At exterior doors, provide weather sweeps applied to door bottoms.

F. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

G. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.8 ALUMINUM FINISHES

A. High-Performance Organic Finish: 3-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   1. Color and Gloss: Match Architect's sample
   2. Number of Colors: Two.
   3. Both solid and metallic colors will be used.
   4. One or more colors will be required to match the aluminum curtain wall exactly.
   5. One or more colors will be required to match the aluminum windows exactly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:
   1. Comply with manufacturer's written instructions.
   2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic
deterioration.
6. Seal joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting
contact surfaces with primer or applying sealant or tape, or by installing nonconductive
spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting
contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members,
and moisture migrating within the system to exterior.

D. Install components plumb and true in alignment with established lines and grades, and without warp
or rack.

E. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware
according to entrance door hardware manufacturers' written instructions using concealed
fasteners to greatest extent possible.

F. Install perimeter joint sealants as specified in Division 07 Section "Joint Sealants" to produce
weathertight installation.

3.3 ERECTION TOLERANCES

A. Install aluminum-framed systems to comply with the following maximum erection tolerances:

1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet; 1/4
inch over total length.
2. Alignment:
   a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch.
   b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch.

B. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch.

3.4 ADJUSTING

A. Adjust operating entrance door hardware to function smoothly as recommended by manufacturer.

1. For entrance doors accessible to people with disabilities, adjust closers to provide a 3-second
closer sweep period for doors to move from a 70-degree open position to 3 inches from the
latch, measured to the leading door edge.
3.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
   1. Separate tempered glass waste for use as aggregate of nonstructural fill.

C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Stainless steel.
   3. Plastic Materials

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 08 41 13
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SECTION 08 41 26 – FRAMELESS GLASS DOORS & STOREFRONT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
1. Interior manual-swinging all-glass entrance doors.
2. Interior all-glass storefronts.
B. Related Sections:
1. Division 05 Section "Metal Fabrications" for overhead-steel support for all-glass systems.
2. Division 08 Section "Glazing" for general glass requirements.

1.3 DEFINITIONS
A. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board’s "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

1.4 PERFORMANCE REQUIREMENTS
A. General Performance: All-glass systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction.
B. Structural Performance: All-glass systems shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
1. Seismic Loads: As indicated on Drawings.
2. Deflection Limits: Deflection normal to glazing plane is limited to 1/175 of clear span or 3/4 inch, whichever is smaller.
C. Delegated Design: Design all-glass systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for all-glass system.
B. Shop Drawings: Show fabrication and installation details, including the following:
1. Plans, elevations, and sections.
2. Details of fittings and glazing, including isometric drawings of patch and rail fittings.
3. Door hardware locations, mounting heights, and installation requirements.

C. Samples for Initial Selection: For each type of exposed finish indicated.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
   1. Metal Finishes: 6-inch-long sections of patch and rail fittings, accessory fittings, and other items.
   2. Glass: 6 inches square, showing exposed-edge finish and all colors & translucencies of glass in project.
   3. Door Hardware: For exposed door hardware of each type, in specified finish, full size.

E. Fabrication Sample: Of patch fitting at sill on pivot side only and continuous rail fitting at bottom of all-glass systems, made from 12-inch lengths of full-size components and showing details of the following:
   1. Joinery.
   2. Anchorage.

F. Other Action Submittals:
   1. Entrance Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

G. Delegated-Design Submittal: For all-glass systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of all-glass systems.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Seismic Qualification Certificates: For all-glass systems, accessories, and components, from manufacturer.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for all-glass systems.

D. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For all-glass systems to include in maintenance manuals.
1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: Curved, laminated, fritted glass manufacturer shall provide proof of 10 years experience in frit application and 20 years experience with laminating and bending glass, and 5 years experience in the manufacturing of heavy tempered glass doors.

B. Installer Qualifications: Manufacturer’s authorized representative who is trained and approved for installation of units required for this Project.
   1. Installer shall provide evidence of three successful installations of similar frameless heavy glass door and wall systems over the past five years.

C. Engineering Responsibility: Prepare data for all-glass systems, including Shop Drawings, based on testing and engineering analysis of manufacturer’s standard units in systems similar to those indicated for this Project.

D. Source Limitations: Obtain all-glass systems from single source from single manufacturer.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockups for all-glass systems including entrance door hardware, patch and rail fittings, and accessory fittings.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Accessible All-Glass Entrance Doors: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board’s ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

G. Preinstallation Conference: Conduct conference at Project site.

1.9 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with all-glass systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of all-glass systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including excessive deflection.
      b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      c. Any defect materially obstructing vision through the glass.
      d. Failure of operating components.
   2. Warranty Period: Five years from date of Substantial Completion, except as follows:
      a. Concealed Floor Closers: Ten years from date of Substantial Completion.
1.11 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of all-glass system Installer. Include quarterly preventive maintenance, repair, or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper all-glass system operation. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.

B. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.1 METAL COMPONENTS

A. Basis-of-Design Product for Patches and other Hardware: The design of the patches and other hardware for the all-glass entrance and storefront is based on the following systems as manufactured by DORMA Glas, Inc., or approved equal.

B. Fitting Configuration for Doors and Transoms

1. Universal Patch Fittings as manufactured by DORMA Glas, Inc., or equal. Required fittings as shown on the Drawings include, but are not limited to:
   a. PT-10 Bottom Patch w/insert for floor closer, pivot, or round pivot 14 mm dia.
   b. PT-20 Top Patch w/safety insert for top pivot 15 mm dia.
   c. PT-30 Transom Patch w/pivot 15 mm dia, w/M8 tapped hole at side OR w/stop insert, w/M8 tapped hole at side OR w/blank insert, w/M8 tapped hole at side OR w/blank insert
   d. PT-40 Transom Sidelight Patch w/pivot 15 mm dia OR w/stop insert OR w/blank insert
   e. PT-62 Transom Sidelite Connector w/fixed stop

2. Manual-Swinging, All-Glass Entrance Doors and Transoms: Provide Dorma-Glas Type A, F & BP glass doors, or equal. Top and bottom patch fittings are 2” x 6 ½” and are made up of 3 components: base fitting, insert and cover.
   a. Base Fitting: Cast Aluminum.
   b. Snap On Cover: ASTM A 666, Type 304. Stainless steel, brushed finish.
   c. Inserts: Combination of aluminum and hardened steel.
   d. Gaskets: Hakosil Fiber Gasket is used to obtain maximum coefficient of friction between glass and aluminum assembly.
   e. Top and bottom patch fittings have inserts to accommodate the pivot/closer mechanisms.
   f. Bottom patch lock is 2 ½” x 6 ½” and has round blot lock which engages into flat mount or dust proof strikes.

C. All-Glass Storefronts: Recessed glazing channel at top and bottom.

   1. Bottom Dri-Fit U-Channel, 1” x 1”, recessed into floor
   2. Top Dri-Fit U-Channel, 1” x 1-3/4”, recessed into ceiling

D. Anchors and Fastenings: Concealed.
2.2 GLASS
A. Material: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent), tested for surface and edge compression per ASTM C 1048 and for impact strength per 16 CFR 1201 for Category II materials.

B. Basis-of-Design Product: Subject to performance requirements, use tempered glass as manufactured by Dlubak Corporation, 800.336.0562, or approved equal.
   1. Glazing Type GL - 7: Clear monolithic tempered.
      a. Thickness: 1/2 inch.
      b. Locations: As indicated.
   2. Glazing Type GL - 8: Translucent tempered.
      a. Color: White
      b. Thickness: NOMINAL 9/16”.
      c. Glass Construction: ¼” clear + 030” Translucent White + ¼” clear.
      d. Glass Interlayer: White, 65% L.T. as supplied by DuPont or Solutia.
      e. Locations: As indicated.

4. Butt Edges: Flat ground.
5. Corner Edges: Lap-joint corners with exposed edges polished.

2.3 ENTRANCE DOOR HARDWARE
A. General: Heavy-duty entrance door hardware units in sizes, quantities, and types recommended by manufacturer for all-glass entrance systems indicated. For exposed parts, match metal and finish of patch fittings.

B. Basis-of-Design Product for Door Hardware: The design of the door hardware for the all-glass entrance and storefront is based on the following systems as manufactured by C.R.Laurence Co., Inc or equal.

C. Concealed Floor Closers and Top Pivots: Center hung; BHMA A156.4, Grade 1; including cases, bottom arms, top walking beam pivots, plates, and accessories required for complete installation.
   1. Swing: Single and Double acting.
      a. Positive Dead Stop: Coordinated with hold-open angle if any, or at angle selected.
   2. Opening-Force Requirements:

D. Single-Door and Active-Leaf Locksets: Center-housing combination deadbolt and latchbolt with lever handles.
   1. Provide center lock glass keeper on jamb opposite latch.

E. Cylinders: As specified in Division 08 Section "Door Hardware."
   1. Locksets must be compatible with Owner’s Best 7-pin keying system.

F. Hardware Finish: ASTM A 666, Type 304, Stainless Steel, brushed finish.
G. Lever Design: Lever design to match levers on doors supplied by others - Schlage “danmark” lever (model 615) as manufactured by Ingersoll Rand.

H. Hardware sets shall be as follows (per door listed):

1) Doors 017a and 420
   1 EA Cylinder lock by others
   1 EA CRL 6’x10” Center Lock w/ danmark 615 lever – classroom function
   1 EA CRL 6’x10” Center Lock Glass Keeper
   1 EA CRL Floor Stop DL2522A

2) Door 115
   1 EA Cylinder Lock by others
   1 EA CRL 6’x10” Center Lock w/ danmark 615 lever – classroom function
   1 EA CRL 6’x10” Center Lock Glass Keeper
   1 EA CRL Wall Stop DL2511A

3) Doors 118, 221 and 417
   1 EA Cylinder Lock by others
   1 EA CRL 6’x10” Center Lock w/ danmark 615 lever – office function
   1 EA CRL 6’x10” Center “Entrance” Lock Glass Keeper
   1 EA CRL Floor Stop DL2522A

4) Doors 219 and 314
   3 EA Cylinder Locks by others
   1 EA CRL 6’x10” Center Lock w/ danmark 615 lever – classroom function
   1 EA CRL 6’x10” Center Lock Glass Keeper
   2 EA CRL Floor Stop DL2522A
   2 EA CRL AMR215 Series Patchlock w/ thumbturn on interior side (one at bottom of inactive leaf, one at top of inactive leaf)
   1 EA CRL Spring-loaded Dustproof Keepers (bottom of inactive leaf)
   1 EA CRL AMR Series Glass Door Mount Keeper to accept patchlock bolt (top of inactive leaf)

5) Door 316a
   1 EA Cylinder Lock by others
   1 EA CRL 6’x10” Center Lock w/ danmark 615 lever – classroom function
   1 EA CRL 6’x10” Center Lock Glass Keeper
   1 EA CRL Floor Stop DL2522A
   1 EA CRL Jackson 900 Series Spring Power Adjustable Floor Closer
   1 EA CRL Bottom Door Patch Fitting with Insert for Floor Closer Spindle

2.4 **FABRICATION**

A. Provide holes and cutouts in glass to receive hardware, fittings, and accessory fittings before tempering glass. Do not cut, drill, or make other alterations to glass after tempering.

1. Fully temper glass using horizontal (roller-hearth) process, and fabricate so that when glass is installed, roll-wave distortion is parallel with bottom edge of door or lite.

B. Factory assemble components and factory install hardware and fittings to greatest extent possible.

2.5 **ALUMINUM FINISHES**

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
2.6 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   1. Run grain of directional finishes with long dimension of each piece.
   2. Directional Satin Finish: No. 4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install all-glass systems and associated components according to manufacturer's written instructions.

B. Set units level, plumb, and true to line, with uniform joints.

C. Maintain uniform clearances between adjacent components.

D. Lubricate hardware and other moving parts according to manufacturer's written instructions.

E. Set, seal, and grout floor closer cases as required to suit hardware and substrate indicated.

F. Install joint sealants as specified in Division 07 Section "Joint Sealants" and to produce weathertight installation.

3.3 ADJUSTING AND CLEANING

A. Adjust all-glass entrance doors and hardware to produce smooth operation and tight fit at contact points and weather stripping.
   1. For all-glass entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches from the latch measured to the leading door edge.

B. Remove excess sealant and glazing compounds and dirt from surfaces.

3.4 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
1. Separate tempered glass waste for use as aggregate of nonstructural fill.

C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 08 41 26
SECTION 08 44 13 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes the following:
   1. Conventionally glazed aluminum curtain walls installed as stick assemblies.
   2. Field-glazed structural-sealant-glazed curtain wall assemblies.
   3. Prefinished alum trim attached to curtain wall.
   4. Insulated aluminum spandrel panels stopped into curtain wall systems.
   5. Miscellaneous aluminum extrusions affixed to curtain wall.
   6. False curtain wall caps attached to other materials as trim.

B. Related Sections:
   1. Miscellaneous aluminum extrusions affixed to curtain wall shall comply with this Section and with Division 5 Section "Decorative Metals."
   2. Division 07 Section "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain walls and for sealants to the extent not specified in this Section.
   3. Division 08 "Aluminum Windows" for coordinating finishes among aluminum fenestration units and for mullion inserts to be attached to curtain wall frame members.
   4. Division 08 Section "Entrance Doors" for aluminum entrance door assemblies and stainless steel doors, and for coordinating finishes among aluminum fenestration units.
   5. Division 08 Section "Sloped Glazing Assemblies" for sloped glazing.

1.3 ALLOWANCES
A. Provide field quality-control testing as part of testing and inspecting allowance.

1.4 PERFORMANCE REQUIREMENTS
A. General Performance: Comply with performance requirements specified, as determined by testing of manufacturer's standard glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   1. Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
   2. Failure also includes the following:
      a. Thermal stresses transferring to building structure.
      b. Glass breakage.
      c. Noise or vibration created by wind and thermal and structural movements.
      d. Loosening or weakening of fasteners, attachments, and other components.
      e. Failure of operating units.

B. Delegated Design: Design glazed aluminum curtain walls, including comprehensive engineering analysis by a qualified professional engineer registered in the state of Pennsylvania, using performance requirements and design criteria indicated.

C. Structural Loads:
1. Wind Loads: Criteria as indicated on Drawings.

D. Structural-Test Performance: Test according to ASTM E 330 as follows:
1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

E. Deflection of Framing Members: At design wind pressure, as follows:
1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each individual glazing lite, 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m) or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.
3. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to two times the length of cantilevered member, divided by 175.

F. Seismic Performance: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
1. Component Importance Factor is 1.25.

G. Story Drift: Accommodate design displacement of adjacent stories indicated.
1. Design Displacement: As indicated on Drawings.
2. Test Performance: Meeting criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement and 1.5 times the design displacement.

H. Water Penetration under Static Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft.

I. Water Penetration under Dynamic Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 15 lb/sq. ft.
1. Maximum Water Leakage: According to AAMA 501.1 No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that is drained to exterior.

J. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
2. Test Interior Ambient-Air Temperature: 75 deg F (24 deg C).
3. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

K. Energy Performance: Glazed aluminum curtain walls shall have certified and labeled energy performance ratings in accordance with NFRC.
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.40 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K) as determined according to NFRC 100.
2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.25 as determined according to NFRC 200.
3. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.02 cfm/sq. ft. of fixed wall area as determined according to ASTM E 283 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft.

4. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC- certified condensation resistance rating of no less than 46 as determined according to NFRC 500.

L. Sound Transmission: Provide glazed aluminum curtain walls with fixed glazing and framing areas having the following sound-transmission characteristics:
   1. Outdoor-Indoor Transmission Class: Minimum 32 when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.

M. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
   1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
   2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.

N. Structural Sealant Joints:
   1. Designed to carry gravity loads of glazing.
   2. Designed to produce tensile or shear stress of less than 20 psi.
   3. Design reviewed and approved by structural-sealant manufacturer.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For glazing sealants used inside the weatherproofing system, documentation including printed statement of VOC content.

C. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
   1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
   2. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
      a. Joinery, including concealed welds.
      b. Anchorage.
      c. Expansion provisions.
      d. Glazing.
      e. Flashing and drainage.
      f. Aluminum channels and trim and anchorages to curtain walls.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

F. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch (300-mm) lengths of full-size components and showing details of the following:
   1. Joinery, including concealed welds.
   2. Anchorage.
5. Flashing and drainage.

G. Delegated-Design Submittal: For glazed aluminum curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and testing agency.

B. Seismic Qualification Certificates: For glazed aluminum curtain walls, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

C. Welding certificates.

D. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components, from manufacturer.
   1. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified preconstruction testing agency, for glazed aluminum curtain walls, indicating compliance with performance requirements.

F. Field quality-control reports.

G. Warranties: Sample of special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating glazed aluminum curtain walls that meet or exceed energy performance requirements indicated and of documenting this performance by certification, labeling, and inclusion in lists.
   1. Manufacturer shall have successfully completed a minimum of 5 glazed assemblies of scope, type, and size as proposed project.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   1. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer’s standard units in systems similar to those indicated for this Project and submission of reports of tests performed on manufacturer’s standard assemblies.
   2. Installer shall have completed a minimum of 5 installations of similar scope and type was the proposed project.

C. Quality Control Program for Structural-Sealant-Glazed System: Develop quality control program specifically for Project. Document quality-control procedures and verify results for aluminum framed systems. Comply with ASTM C 1401 recommendations including, but not limited to, system material-qualification procedures, preconstruction sealant-testing program, procedures for system fabrication and installation, and intervals of reviews and checks.
D. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.

E. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.
2. Manufacturer shall not modify framing depths from those indicated. If required, manufacturer shall provide internal aluminum or steel reinforcement of curtain wall members to meet Performance Requirements.
3. Manufacturer shall not revise direction or orientation of primary framing members as indicated.
4. Manufacturer shall not modify indicated attachment methods of curtain wall framing or support to adjacent construction.

F. Preconstruction Sealing Testing: For structural-sealant-glazed systems, perform sealant manufacturer's standard tests for compatibility with and adhesion of each material that will come in contact with sealants and each condition required by aluminum-framed systems.
1. Test a minimum of five samples each of metal, glazing and other material.
2. Prepare samples using techniques and primers required for installed systems.
3. Perform tests under environmental conditions that duplicate those under which assemblies will be installed.
4. For materials that fail tests, determine corrective measures necessary to prepare each material to ensure compatibility with and adhesion of sealants including, but not limited to, specially formulated primers. After performing these corrective measures on the minimum number of samples required for each material, retest materials.

G. Source Limitation for Aluminum-Framed Systems: Obtain all curtain wall, storefront and entrances from single source manufacturer.

H. Single installation responsibility: The following components shall be installed by single installation company:
1. Aluminum framing system specified in this section.
2. Sheet metal fabrications and flashings required for joints between aluminum framing and adjacent construction specified in Division 7 Section "Flashing and Sheet Metal."
3. Weatherproofing sealants specified in Division 7 Section “Joint Sealants.”
4. Aluminum glazed door assemblies to be installed in aluminum framing system as specified in Division 8 Section "Aluminum Doors."
5. Glazing specified in Division 8 Section “Glazing.”
6. Alum trim.


J. Structural-Sealant Joints: Design reviewed and approved by structural-sealant manufacturer.

K. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

L. Energy Performance Standards: Comply with NFRC for minimum standards of energy performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
1. Provide NFRC-certified glazed aluminum curtain walls with an attached label.
M. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockup of typical wall area as directed by Architect. Glazed aluminum curtain wall mockup shall be incorporated into construction of mockup of adjacent building construction materials.
   2. Field testing shall be performed on mockups according to requirements in "Field Quality Control" Article.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

N. Preinstallation Conference: Conduct conference at Project site.

1.9 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for glazed aluminum curtain walls by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 WARRANTY

A. Special Assembly Warranty: Standard form in which [manufacturer] agrees to repair or replace components of glazed aluminum curtain walls that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Noise or vibration created by wind and thermal and structural movements.
      c. Deterioration of metals and other materials beyond normal weathering.
      d. Water penetration through fixed glazing and framing areas.
      e. Failure of operating components.
   2. Warranty Period: Five years from date of Substantial Completion.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: The design of the glazed aluminum curtain wall assembly is based on the following systems as manufactured by Schüco International KG, or approved equal:
   1. FW 50+
   2. FW 50+ SG

B. Subject to compliance with requirements, provide the named products or comparable products that meet the sightlines, sizes, configuration, construction, details (including corner details), finish and all other requirements of this Section as manufactured by one of the following:
   1. Kawneer North America; an Alcoa company.
   2. Vistawall Architectural Products; The Vistawall Group; a Bluescope Steel company.
2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated. Shall be comprised of a minimum of 35% recycled material.
   2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
   4. Structural Profiles: ASTM B 308/B 308M.
   5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
   1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
   3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.3 FRAMING

A. Framing Members: Manufacturer's standard extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
      a. Thermal break to be constructed of a polyamide material with a minimum depth of \( \frac{3}{4} \)".
   2. Glazing System: Retained mechanically with gaskets on four sides.
      a. FW 50+: Outside glazed pressure plate format.
      b. FW 50+ SG (Wet-Sealed Joints): Outside glazed silicone glazed (SSG) format.

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   2. Reinforce members as required to receive fastener threads.
   3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system, fabricated from 300 series stainless steel.

D. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
   1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
   2. Provide special anchors or attachments where indicated and at other locations where attachment will remain exposed to view.

E. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials. Form exposed flashing from sheet aluminum finished to match framing and of sufficient thickness to maintain a flat appearance without visible deflection.

F. Framing Sealants: Manufacturer's standard sealants.

2.4 GLAZING

A. Glazing: Comply with Division 08 Section "Glazing."
B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing Sealants: For structural-sealant-glazed curtain walls, as recommended by manufacturer for joint type, and as follows:
   1. Structural Sealant: ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtain-wall assembly indicated.
      a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      b. Color: As selected by Architect from manufacturer's full range of colors.
   2. Weatherseal Sealant: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.
      a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      b. Color: Matching structural sealant.

2.5 OPERABLE UNITS

A. Doors: Comply with Division 08 Section "Aluminum Entrance Doors & Frames."

2.6 PREFINISHED ALUMINUM TRIM

A. Exterior and Interior Extruded Aluminum Trim: Prefinished aluminum sections as indicated on Drawings.

2.7 INSULATED ALUMINUM FILLER PANELS

A. Insulated Spandrel Panels: Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.
   1. Overall Panel Thickness: 1 inch.
   2. Exterior Skin: Aluminum.
      a. Thickness: Manufacturer's standard for finish and texture indicated.
      b. Finish: Matching framing system.
      c. Texture: Smooth.
      d. Backing Sheet: Manufacturer's standard.
   3. Interior Skin: Aluminum.
      a. Thickness: Manufacturer's standard for finish and texture indicated.
      b. Finish: Matching curtain-wall framing where exposed, manufacturer's option where concealed.
      c. Texture: Smooth.
      d. Backing Sheet: Manufacturer's standard.
   4. Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board.

2.8 ACCESSORY MATERIALS

A. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

B. Miscellaneous Trim and Closures: Extruded or fabricated by aluminum-frame system manufacturer from aluminum sheet in finish to match aluminum framing system. Profiles as indicated or otherwise required. All fasteners for attachment to be concealed.
C. Gaskets and Vapor Barriers: Glazing gaskets shall comply with ASTM C 864 and be extruded of a silicone compatible EPDM rubber that provides for silicone adhesion.
   1. Profiles to be specifically designed for framing system and capable of being removed and replaced.

D. Thermal Barrier: Thermal separator shall be extruded of a silicone compatible elastomer that provides for silicone adhesion.
   1. High density plastic isolator thermally breaking pressure plate from mullion.

2.9 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Physical and thermal isolation of glazing from framing members.
   4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   5. Provisions for field replacement of glazing from exterior.
   6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Fabricate components that, when assembled, have the following characteristics:
   1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
   2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.

E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.10 ALUMINUM FINISHES

A. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   2. Number of Colors: There will be three (3) colors used for items specified in this section.
   3. Both solid and metallic colors will be used.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 INSTALLATION

A. General:
   1. Comply with manufacturer's written instructions.
   2. Do not install damaged components.
   3. Fit joints to produce hairline joints free of burrs and distortion.
   4. Rigidly secure nonmovement joints.
   5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic
deterioration and to prevent impeding movement of moving joints.
   6. Weld components in concealed locations to minimize distortion or discoloration of finish.
   7. Seal joints watertight unless otherwise indicated.

B. Metal Protection:
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting
   contact surfaces with primer or by applying sealant or tape or installing nonconductive
   spacers as recommended by manufacturer for this purpose.
   2. Where aluminum will contact concrete or masonry, protect against corrosion by painting
   contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members,
and moisture migrating within glazed aluminum curtain wall to exterior.

D. Install components plumb and true in alignment with established lines and grades.

E. Install glazing as specified in Division 08 Section "Glazing."

3.3 ERECTION TOLERANCES

A. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum
   tolerances:
   1. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6 mm in 12 m).
   2. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6 mm in 12 m).
   3. Alignment:
      a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2
         inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
      b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7
to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
      c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm)
         wide or more, limit offset from true alignment to 1/4 inch (6 mm).
   4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.7 m); 1/2 inch (12.7
      mm) over total length.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of representative areas of glazed aluminum curtain walls
shall take place as installation proceeds to determine compliance of installed assemblies with
specified requirements.
   1. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for
   laboratory testing in "Performance Requirements” Article, but not more than 0.50 cfm/sq. ft.
   (2.25 L/s per sq. m), of fixed wall area when tested according to ASTM E 783 at a minimum
   static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
      a. Test Area: One bay wide, but not less than 30 feet (9.1 m), by one story of glazed
         aluminum curtain wall.
      b. Perform a minimum of four tests in areas as directed by Architect. One test area for
         each type of curtain wall installed.
2. Water Penetration: Areas shall be tested according to ASTM E 1105 at a minimum uniform static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.
   a. Test Area: One bay wide, but not less than 30 feet (9.1 m), by one story of glazed aluminum curtain wall.
   b. Perform a minimum of four tests in areas as directed by Architect. One test area for each type of curtain wall installed.

3. Water Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
   a. Test Area: A minimum area of 75 feet (23 m) by one story of glazed aluminum curtain wall.

3.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
   1. Separate tempered glass waste for use as aggregate of nonstructural fill.

C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 08 44 13
SECTION 08 44 23–STEEL FIRE RATED GLAZED CURTAINWALL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:
   1. Interior fire-rated curtain wall system, including glazing, perimeter trims, accessories, shims and anchors, and perimeter sealing of curtain wall framing to be installed as a one-hour wall assembly.

B. Related Sections include the following:
   1. Division 7 Section "Fire-Resistive Joint Systems" for perimeter fire-containment systems (safing insulation) field installed with steel fire-rated glazed curtain-wall systems.
   2. Division 7 Section "Joint Sealants" for installation of joint sealants installed with steel fire-rated glazed curtain-wall systems and for sealants to the extent not specified in this Section.
   3. Division 8 Section “Door Hardware” for door hardware not provided in this Section.

1.3

1.4 REFERENCES

A. American Society for Testing and Materials (ASTM):
   2. ASTM E2074-00

B. National Fire Protection Association (NFPA):
   3. NFPA 257: Fire Test of Window Assemblies

C. Underwriters Laboratories, Inc. (UL):
   1. UL 10 B: Fire Tests of Window Assemblies
   2. UL 263: Fire tests of Building Construction and Materials
   3. UL 10 C: Positive Pressure Fire Tests of Window & Door Assemblies

D. American National Standards Institute (ANSI):

E. Consumer Product Safety Commission (CPSC):

1.5 PERFORMANCE REQUIREMENTS

A. General: Provide steel fire-rated glazed curtain-wall systems, including anchorage, capable of withstanding, without failure, the effects of the following:
   1. Structural loads.
2. Thermal movements.
3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
4. Dimensional tolerances of building frame and other adjacent construction.
5. Failure includes the following:
   a. Deflection exceeding specified limits.
   b. Thermal stresses transferred to building structure.
   c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
   d. Noise or vibration created by wind and thermal and structural movements.
   e. Loosening or weakening of fasteners, attachments, and other components.
   f. Sealant failure.

B. System Description:
1. Steel fire-rated glazed curtain wall system, outside glazed pressure plate, cover cap format.
2. Face Width:
   a. 1 3/4-inch.

C. Structural Loads:
1. Seismic Loads: As indicated on structural drawings.

D. Duration of Fire Rating – Window/Walls: Capable of providing a fire rating for 120 minutes, or as noted in the Drawings.

E. Duration of Fire Rating – Doors: Capable of providing a fire rating for 90 minutes, as noted in the Door Schedule.

1.6 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, connections to adjacent construction, and finishes for each type of product indicated.

B. LEED Submittals:
1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
   a. Steel.
   b. Mineral fiber wool insulation.
2. Credit MR 5.1 and 5.2: Manufacturers certificate demonstrating that each material or product indicated was extracted, harvested or recovered, as well as manufactured within 500 miles of the project site.

C. Shop Drawings: Show doors, frames, hardware and steel frame components as shown on shop drawings and schedules
1. Prepared by or under the supervision of a qualified professional engineer detailing fabrication and assembly of steel fire-rated glazed curtain-wall systems.
2. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Obtain Architect’s approval before fabrication.

E. Samples for Initial Color Selection:
1. Manufacturer's color charts showing the full range of colors available.

F. Samples: For following products:
1. Two 8-inch by 10-inch Samples for glass.
G. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.


I. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

J. Pre-Installation Meeting: Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for Project and whose work has resulted in construction with a record of successful in-service performance.

1. Engineering Responsibility: Preparation of data for glazed curtain-wall systems including the following:
   a. Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Source Limitations for Glazing Accessories: Obtain glazing accessories from one source for each product and installation method indicated.

C. Fire-Rated Window Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by UL, for fire ratings indicated, based on testing according to NFPA 257, ASTM E119. Assemblies must be factory-welded or come complete with factory-installed mechanical joints and must not require job site fabrication.

D. Certification: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

3. Underwriters Laboratories (UL) shall conduct fire test.

E. Listings and Labels - Fire Rated Assemblies: Under current follow-up service by an approved independent agency maintaining a current listing or certification. Label assemblies accordance with limits of manufacturer’s listing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and handle under provisions specified by manufacturer. (For details on storage and product handling, please contact Technical Glass Products and request information on storage and product handling.)

B. Deliver materials to specified destination in manufacturer or distributor’s packaging undamaged, complete with installation instructions.

C. Store off ground, under cover, protected from weather and construction activities.
1.9  PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for steel fire-rated glazed curtain-wall systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10  WARRANTY

A. Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of steel fire-rated glazed curtain-wall systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Noise or vibration caused by thermal movements.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      d. Water leakage.
      e. Failure of operating components to function normally.
   2. Warranty Period - Pyrostop and Fire Frame: Five years from date of Substantial Completion.

B. Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
   1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1  MANUFACTURERS – FIRE RATED DOOR/WINDOW/WALL ASSEMBLY

A. Basis-of-Design Product: The design for each element of the assembly is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by another manufacturer which meets all of the requirements of this section.

B. Basis of Design for Glazing Material for Frame System: “Pyrostop®” fire-rated glazing as manufactured by the Pilkington Group and distributed by Technical Glass Products, 8107 Bracken Place SE, Snoqualmie, WA 98065 (800-426-0279) fax (800-451-9857) e-mail sales@fireglass.com, web site http://www.fireglass.com
   1. Laminated Glass with Intumescent Interlayers: Proprietary Category II safety glazing product in the form of multiple lites of Condition A (uncoated surfaces), Type I (transparent glass, flat), Class 1 (clear), Kind FT (fully tempered) float glass laminated with intumescent interlayers.


2.2 MATERIALS – GLASS

   1. Interior double glazing Pyrostop 120 to be installed in Curtainwall: 2-1/8” nominal thickness.

B. **Glazing Type 12 (GL 12)** - Fire Rated Glazing for Walls with Fritted Glass: ASTM C 1036 and ASTM C 1048; ‘Pyrostop’ Insulated glass unit composed of multiple sheets of Pilkington “Optiwhite” high visible light transmission glass laminated with an intumescent interlayer, a ¼” air space, and another layer of ¼” tempered glass with ceramic frit pattern on interior surface (within airspace).
   1. Interior double glazing Pyrostop 120 to be installed in Curtainwall: 1-9/16” nominal thickness + 8mm air space + ¼” fritted tempered glass = nom. 2-1/8”.

C. **Glazing Type 9 (GL 9)** - Fire Rated Glazing for Doors with Clear Glass: “Firelite Plus” IGU, 1” thick.

D. **Glazing Type 11 (GL 11)** - Fire Rated Glazing for Doors with Fritted Glass: “Firelite Plus” IGU, 1” thick, with ceramic frit pattern applied to the ¼” tempered outboard lite (within airspace).

E. Fritted Glass:
   1. Simulated acid etch coating: (Basis of Design) V1085 screen #3058, simulated acid etch, full coverage on interior surface (within airspace).
   2. One color of ceramic frit will be used in both Pyrostop and Firelite glazing.
   3. Aesthetic Effect: The simulated acid etch product listed establishes the standard (texture, density, translucence) which must be met by any other product to be considered an acceptable equal.

F. Approximate Visible Transmission before application of frit pattern: Varies with thickness (approximate range 75 to 88 percent).

G. Logo: Each piece of fire-rated glazing shall be labeled with a permanent logo including name of product, manufacture, testing laboratory (UL), fire rating period, safety glazing standards, and date of manufacture.

2.3 MATERIALS – STEEL FRAMING

A. Steel Curtainwall Framing System with 120 min. rating, as noted on the Drawings.
   1. Steel Frame: Profiled steel tubing permanently joined with steel bolts.
   2. Insulation: Insulate framing system against effects of fire, smoke, and heat transfer from either side. Insulate profiled steel tubing using a shell construction that incorporates Promatect-H intermediate interlayer. Firmly pack perimeter of framing system to rough opening with mineral wool fire stop insulation or appropriately rated intumescent sealant.
   3. Steel Glazing Beads: Extruded steel beads with dimensions recommended by manufacturer to securely hold glazing material in place.
   4. Fasteners: Type recommended by manufacturer
   5. Glazing Accessories: Set Pyrostop glass using calcium silicate, or setting blocks.
   6. Glazing Gaskets, Compounds and tapes: Glaze Pyrostop glass with approved EPDM glazing gaskets and closed cell PVC tape, or pure silicone sealant.

B. Steel Reinforcement: With manufacturer’s standard corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
   1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   2. Cold-Rolled Sheet and Strip: ASTM A 611.
   3. Hot-Rolled Sheet and Strip: ASTM A 570/A 570M.
C. Brackets and Reinforcements: Manufacturer's standard high-strength materials with nonstaining, nonferrous shims for aligning system components.

D. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Where fasteners are subject to loosening or turn out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
   2. Reinforce members as required to receive fastener threads.
   3. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended by manufacturer.

E. Anchors: Three-way adjustable anchors that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
   1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

F. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

2.4 ACCESSORIES

A. Exposed Fasteners: Use fasteners fabricated from Type 304 or Type 316 stainless steel.

B. Glazing Gaskets:
   1. Interior Applications: Glaze Pyrostop glass with approved, or pure silicone sealant.

C. Intumescent Tape: As supplied by frame manufacturer.

D. Setting Blocks: Calcium silicate.

E. Perimeter Anchors: Steel or 316 Stainless steel when exposed.

F. Flashings: As recommended by manufacturer; same material and finish as cover caps.

G. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):
   1. Architectural Sealants: 250 g/L.
   2. Sealant Primers for Nonporous Substrates: 250 g/L.
   3. Sealant Primers for Porous Substrates: 775 g/L.

H. Silicone Sealant: One-Part Low Modulus, High Movement-Capable Sealant: Type S; Grade NS; Class 25 with additional movement capability of 100 percent in extension and 50 percent in compression (total 150 percent); Use (Exposure) NT; Uses (Substrates) M, G, A, and O as applicable. (Use-O joint substrates include: Metal factory-coated with a high-performance coating; galvanized steel; ceramic tile.)
   1. Available Products: Subject to compliance with requirements, provide one of the following:
     a. Dow Corning 790 - Dow Corning Corp.

I. Intumescent Caulk: Single component, latex-based, intumescent caulk designed to stop passage of fire, smoke, and fumes through fire-rated separations; permanently flexible after cure; will not support mold growth; flame spread/smoke developed 10/10.
   1. Available Products: Subject to compliance with requirements, provide one of the following:
2.5 SLAG-WOOL-FIBER/ROCK-WOOL-FIBER INSULATION

A. Available Manufacturers:
   1. Fibrex Insulations Inc.
   2. Owens Corning.
   3. Thermafiber.

B. Unfaced, Slag-Wool-Fiber/Rock-Wool-Fiber Board Insulation: ASTM C 612, maximum flame-spread and smoke-developed indexes of 15 and 0, respectively; passing ASTM E 136 for combustion characteristics; and of the following nominal density and thermal resistivity:
   1. Nominal density of 4 lb/cu. ft. (64 kg/cu. m), Types IA and IB, thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F (27.7 K x m/W at 24 deg C).
   2. Fiber Color: Regular color, unless otherwise indicated.

2.6 FABRICATION

A. General:
   1. Fabricate components per manufacturer's installation instructions and with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.
   2. Accurately fit and secure joints and corners. Make joints flush and weatherproof.
   3. Prepare components to receive anchor devices.
   4. Fabricate anchors.
   5. Arrange fasteners and attachments to be concealed from view.

2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish doors, frames and curtain wall after assembly.

C. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.8 INTERIOR STEEL FINISHES

A. Color-Coated Finish: Apply manufacturer's standard powder coating finish system applied to factory-assembled frames before shipping, complying with manufacturer's written instructions for surface preparation including pretreatment, application, and minimum dry film thickness.
   2. Two colors will be required.
   3. Solid and metallic colors will be required.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions: Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions. Verify openings are sized to receive curtain wall system and sill plate is level in accordance with manufacturer's acceptable tolerances.
   1. Field Measurements: Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on shop drawings. Coordinate field measurements, fabrication schedule with construction progress to avoid construction delays.
B. Provide openings plumb, square and within allowable tolerances.

C. Notify Architect of any conditions which jeopardize the integrity of the proposed fire wall / door system. Do not proceed until such conditions are corrected.

3.2 INSTALLATION

A. General: Install curtain wall systems plumb, level, and true to line, without warp or rack of frames with manufacturer’s prescribed tolerances and installation instructions. Provide support and anchor in place.

B. Install fire curtain wall by a specialty contractor with appropriate experience qualifications; and in strict accordance with the approved shop drawings. Employ experienced mechanics familiar with this type of specialized work.

C. Glazing: Glass shall be outside glazed and held in place with stainless steel pressure plates anchored to the mullion using stainless steel fasteners spaced no greater than 12-inches on center.

D. Install glazing in strict accordance with fire resistant glazing material manufacturer’s specifications. Field cutting or tampering is not permissible.

E. Firmly pack perimeter of framing system to rough opening with mineral wool fire stop insulation or appropriately rated intumescent sealant.

3.3 PROTECTION AND CLEANING

A. Protect glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.

C. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents, and vandalism, during construction period.

D. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer.

3.4 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
   1. Separate tempered glass waste for use as aggregate of nonstructural fill.

C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.
D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

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SECTION 08 44 33 - SLOPED GLAZING ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Low-slope glazing assembly.

B. Related Sections:
   1. Division 05 Section "Structural Steel Framing" for steel framing that supports sloped glazing framing members.
   2. Division 07 Section "Joint Sealants" for installation of joint sealants installed with sloped glazing assemblies.
   3. Division 08 Section "Glazing" for requirements for glazing sloped glazing assemblies.

1.3 ALLOWANCES

A. Provide field quality control as part of testing and inspecting allowance.

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Sloped glazing assemblies shall withstand movements of supporting structure (where applicable) without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   1. Sloped Glazing Assemblies: Comply with performance requirements specified, as determined by testing manufacturer's standard assemblies representing those indicated for this Project.
   2. Failures also include, but are not limited to, the following:
      a. Thermal stresses transferring to building structure.
      b. Glass breakage.
      c. Noise or vibration created by wind and thermal and structural movements.
      d. Loosening or weakening of fasteners, attachments, and other components.
      e. Failure of operating units.

B. Delegated Design: Design sloped glazing assemblies, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Structural Performance: Sloped glazing assemblies shall withstand the wind loads, the effects of gravity loads, and loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Wind Loads: As indicated on Drawings.
      a. Basic Wind Speed: As indicated on Drawings.
      b. Importance Factor: As indicated on Drawings.
      c. Exposure Category: As indicated on Drawings.
   2. Snow Loads: As indicated on Drawings.
   3. Concentrated Live Loads: As indicated on Drawings, applied to framing members at locations that will produce greatest stress or deflection.
   4. Uniform Live Loads: As indicated on Drawings.
5. Load Combinations: Calculate according to requirements of applicable code indicated on Drawings.

D. Structural Performance: Provide sloped glazing assemblies tested according to ASTM E 330, as follows:
   1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
   2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
   3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

E. Deflection of Framing Members: At design wind pressure, as follows:
   1. Deflection Normal to Glazing Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19.1 mm), whichever is less.
   2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm).

F. Flexural Members: Design for lateral bracing of compression flanges by cross members with minimum depth equal to 50 percent of braced flexural member. Glazing does not provide lateral support.

G. Seismic Performance: Sloped glazing assemblies shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. Component Importance Factor is 1.25.

H. Water Penetration under Static Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).

I. Water Penetration under Dynamic Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 25 lbf/sq. ft.
   1. Maximum Water Leakage: According to AAMA 501.1 No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that is drained to exterior.

J. Thermal Movements: Allow for thermal movements from the following maximum change (range) in ambient and surface temperature:
   1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
   2. Test Interior Ambient-Air Temperature: 75 deg F (24 deg C).
   3. Performance: No buckling, stress on glass, sealant failure, or excess stress on framing, anchors, and fasteners and no reduction of performance when tested according to AAMA 501.5.

K. Energy Performance: Sloped glazing assemblies shall have certified and labeled energy-performance ratings according to the NFRC.
   1. Thermal Transmittance (U-Factor): Fixed glazing and framing areas shall have U-factor of not more than 0.4 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K) as determined according to NFRC 100.
   2. Solar Heat-Gain Coefficient: Refer to Division 08 Section ‘Glazing’ for SHGC requirements.
3. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.30 cfm/sq. ft. (1.50 L/s per sq. m) of fixed area as determined according to ASTM E 283 at a minimum static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
4. Condensation Resistance: Fixed glazing and framing areas shall have an AAMA-certified CRF rating of not less than 60 @ 20% RH as determined according to AAMA 1502.7.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. LEED Submittals:
1. Product Data for Credit IEQ 4.1: For glazing sealants used inside the weatherproofing system, documentation including printed statement of VOC content.

C. Shop Drawings: For sloped glazing assemblies. Include plans, elevations, sections, details, and attachments to other work.
1. Include details of provisions for assembly expansion and contraction and for draining moisture within the assembly to the exterior.
2. Include full-size isometric details of each vertical-to-horizontal intersection of assembly, showing the following:
   a. Joinery including concealed welds.
   b. Anchorage.
   c. Expansion provisions.
   d. Glazing.
   e. Flashing and drainage.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

F. Fabrication Sample: Of each framing intersection of assemblies, made from 12-inch (300-mm) lengths of full-size components and showing details of the following:
1. Joinery including concealed welds.
2. Anchorage.
5. Flashing and drainage.

G. Delegated-Design Submittal: For sloped glazing assemblies indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and testing agency.

B. Seismic Qualification Certificates: For sloped glazing assemblies, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sloped glazing assemblies.

D. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C 1401. Include periodic quality-control reports.
E. Source quality-control reports.

F. Field quality-control reports.

G. Warranties: Sample of special warranties.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   1. The skylight assembly shall be completely erected by the manufacturer or under the manufacturer's direct supervision.

B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.

C. Design the skylight system using the “Step Down Principle” with the following characteristics:
   1. An interior (roomside) air seal at all component interfaces
   2. An exterior (weatherside) deterrent seal formed by continuous gaskets
   3. A glazing pocket vented to the exterior
   4. Extrusions with integral gutters of sufficient depth to carry all intruded rainwater/snowmelt to the exterior
   5. Condensation formed on the roomside surfaces shall be allowed to re-evaporate

D. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
   1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

E. NFRC Certification: Provide NFRC-certified and -labeled sloped glazing assemblies.

F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockups of typical sloped glazing assembly area as directed by Architect.
   2. Field testing shall be performed on mockups according to requirements in "Field Quality Control" Article.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

G. Preinstallation Conference: Conduct conference at Project site.

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for sloped glazing assemblies by field measurements before fabrication.

1.9 WARRANTY

A. Special Assembly Warranty: Standard form in which manufacturer agrees to repair or replace components of sloped glazing assemblies that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Noise or vibration created by wind and thermal and structural movements.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
d. Water penetration through fixed glazing and framing areas.
e. Failure of operating components.

2. Warranty Period: Five years from date of Substantial Completion.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide low-slope glazing assembly by Inter-Sky Skylight Specialties, or comparable product.

Inter-sky skylight specialties
1305 S. Lyon St., Santa Ana, CA 92705
Ph: 714.972.9112
Fax: 714.972.9113
Ph: 1.800.972.9112
E-Mail: info@inter-sky.com

2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
4. Structural Profiles: ASTM B 308/B 308M.

B. Steel Reinforcement, if required: With manufacturer's standard, zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.3 FRAMING

A. Framing Members: Manufacturer's standard, formed- or extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Framing-Member Type: Self-supporting.
2. Glass Retention: Field-installed pressure caps on three sides.

B. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
1. Include snap-on aluminum trim that conceals fasteners.
C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning assembly components.

D. Fasteners and Accessories: Manufacturer’s standard, corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. At pressure caps, use ASTM A 193/A 193M stainless-steel screws.
   2. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   3. Reinforce members as required to receive fastener threads.
   4. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system, fabricated from Series 300 stainless steel.

E. Anchors: Three-way adjustable anchors, with minimum adjustment of 1 inch (25 mm), that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials, and recommended by manufacturer.
   1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with requirements in ASTM A 123/A 123M or ASTM A 153/A 153M.

F. Anchor Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), galvanized steel.

G. Concealed Flashing: Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

H. Exposed Flashing and Closures: Manufacturer's standard aluminum components not less than 0.040 inch (1.016 mm) thick.

I. Framing Sealants: Manufacturer's standard.

2.4 GLAZING

A. General: Comply with Division 08 Section "Glazing."

B. Glazing Gaskets: Dense EPDM Durometer 50 (shore A) per ASTM C-509. When structural silicone is used for capless glazing applications, use compatible gaskets recommended by the sealant manufacturer.

C. Glass Setting Blocks: Compatible with glass edge seals, with a durometer between 70 and 90 (shore A.)

D. Glazing Sealants: Silicone, as recommended by manufacturer.
   1. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Compatible with all substrates and develop full adhesive and cohesive strength when subjected to design loads/movements. Silicone shall be neutral cure, medium to high modulus.

2.5 ACCESSORY MATERIALS

A. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 33 requirements except containing no asbestos, formulated for 30-mil (0.76-mm) thickness per coat.

B. Cleaning Agent and Cloth: As recommended by structural-sealant manufacturer.

2.6 FABRICATION

A. Form or extrude aluminum shapes before finishing.
B. Fabricate components that, when assembled, have the following characteristics:
1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
6. Components curved to indicated radii.
7. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

C. Fabricate continuous, one-piece-type aluminum sill closures with weep holes.

D. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.7 ALUMINUM FINISHES

A. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Number of Colors: One.
3. Type of Color: Metallic.
4. Color must match one of the curtain wall colors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:
1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and impediments to movement of joints.
6. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
7. Seal joints watertight unless otherwise indicated.

B. Metal Protection:
1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
3. Where aluminum will contact pressure-treated wood, separate dissimilar materials by method recommended by sloped glazing assembly manufacturer.

C. Install continuous sill closure with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.

D. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the sloped glazing assembly to exterior.

E. Install components plumb and true in alignment with established lines and grades.

F. Install glazing as specified in Division 08 Section "Glazing."

3.3 ERECTION TOLERANCES

A. General: Install sloped glazing assemblies to comply with the following maximum tolerances:
1. Level: 1/8 inch in 20 feet (3 mm in 6 m); 1/4 inch in 40 feet (6 mm in 12 m).
2. Alignment: Limit offset from true alignment to 1/32 inch (0.8 mm) where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches (76 mm); otherwise limit offset to 1/8 inch (3 mm).
3. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/2 inch (13 mm) over total length.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of representative areas of sloped glazing assemblies shall take place as installation proceeds to determine compliance of installed assemblies with specified requirements.
1. Water Penetration: Areas shall be tested according to ASTM E 1105 at a minimum uniform and cyclic static-air-pressure difference of 0.67 times the static-air-pressure difference specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.
   a. Test Area: Entire skylight
   b. Perform a minimum of two tests in areas as directed by Architect.
   c. Perform tests in each test area as directed by Architect. Perform tests prior to 70 percent completion.
2. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
   a. Test Area: Test entire skylight.

C. Sloped glazing assemblies will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
   1. Separate tempered glass waste for use as aggregate of nonstructural fill.
C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 08 44 33
SECTION 08 51 13 - ALUMINUM WINDOWS  [C]

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes:
   1. Fixed and operable aluminum windows for exterior locations.
   2. Mullion inserts to be installed in aluminum entrance doors and curtain wall transoms.

B. Related Requirements:
   1. Division 08 Section “Entrance Doors” for coordinating finish among aluminum fenestration units and for insertion of mullion units into entry doors.
   2. Division 08 Section “Glazed Aluminum Curtain Walls” for coordinating finish among aluminum fenestration units and for insertion of mullion units into transoms above entry doors.
   3. Division 08 Section “Glazing.”

1.3 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.
   1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   2. Review and discuss the finishing of aluminum windows that is required to be coordinated with the finishing of other aluminum work for color and finish matching.
   3. Review, discuss, and coordinate the interrelationship of aluminum windows with other exterior wall components. Include provisions for anchorage, flashing, sealing perimeters, and protecting finishes.
   4. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
   5. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.
B. Shop Drawings: Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation. Include the following:
   1. Mullion details, including reinforcement and stiffeners.
   2. Joinery details.
   4. Flashing and drainage details.
   5. Weather-stripping details.
   7. Glazing details.
   8. Window cleaning provisions.

C. Samples for Initial Selection: For units with factory-applied color finishes.
   1. Include similar Samples of hardware and accessories involving color selection.

D. Samples for Verification: For aluminum windows and components required, showing full range of color variations for finishes, and prepared on Samples of size indicated below:
   1. Window Corner Fabrication: 12” x 12” long, full-size window corner including full-size sections of extrusions with factory-applied color finish, weather stripping, and glazing.
   2. Operable Window: Full-size unit with factory-applied finish to be included in mockup.
   3. Hardware: Full-size units with factory-applied finishes.

E. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and Installer.

B. Product Test Reports: For each type of aluminum window, for tests performed by a qualified testing agency.

C. Sample Warranties: For manufacturer’s warranties.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports, and calculations.

B. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.

C. Product Options: Information on Drawings and in Specifications establishes requirements for aluminum windows’ aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of typical wall area as indicated by Architect.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

E. Air Barrier System Preinstallation Conference: Participate in conference at Project Site. Requirements for conference are described in Division 07 Section "Fluid-Applied Air and Vapor Barriers.

1.7 PROJECT CONDITIONS
A. Field Measurements: Verify aluminum window openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating aluminum windows without field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to established dimensions.

1.8 WARRANTY
A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Failure to meet performance requirements.
   b. Structural failures including excessive deflection, water leakage, condensation, and air infiltration.
   c. Faulty operation of movable sash and hardware.
   d. Deterioration of materials and finishes beyond normal weathering.
   e. Failure of insulating glass.

2. Warranty Period:
   a. Window: 5 years from date of Substantial Completion.
   b. Glazing Units: 10 years from date of Substantial Completion.
   c. Aluminum Finish: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Basis-of-Design Product for Windows: Subject to compliance with requirements, provide Custom Window Series 8300-sq (Square) fixed, casement and awning windows, by Custom Window Company, or a comparable product by manufacturers including, but not limited to, one of the following:

1. Custom Window Company.
2. EFCO Corporation; a Pella company.
B. Basis-of-Design Product for Divided Light Mullion Insert: Subject to compliance with requirements, provide Custom Window Series 8600-sq (Square) fixed divided light mullion insert by Custom Window Company, or a comparable product by manufacturers including, but not limited to, one of the following:
1. Custom Window Company.
2. EFCO Corporation; a Pella company.

C. Source Limitations: Obtain aluminum windows from single source from single manufacturer.

2.2 WINDOW PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Window Certification: AMMA certified with label attached to each window.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: AW.
2. Minimum Performance Grade: 100.

C. Air Infiltration Test
1. With window sash and ventilators closed and locked, test unit in accordance with ASTM E 283 at static air pressure of 6.24 psf.
2. Air infiltration shall not exceed .03 cfm per foot of perimeter crack length.

D. Water Resistance Test
1. With window sash and ventilators closed and locked, test unit in accordance with ASTM E 331 at static pressure difference of 12.00 psf.
2. There shall be no uncontrolled water leakage.

E. Uniform Load Deflection Test
1. With window sash and ventilators closed and locked, test unit in accordance with ASTM E 330 at a static air pressure difference (positive and negative) of 100 psf.
2. During the course of the test, no member shall deflect more than 1/175 of its span.

F. Uniform Load Structural Test
1. With window sash and ventilators closed and locked, test unit in accordance with ASTM E 330 at a static air pressure difference of 150 psf.
2. At conclusion of test there shall be no glass breakage, permanent damage to fasteners, hardware parts, support arms or actuating mechanisms, nor any other damage which would cause the window to be inoperable.

G. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of 0.40 Btu/sq. ft. x h x deg F, when tested in accordance with AAMA 1503.1 with window sash and ventilators closed and locked.

H. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of 0.27. [C]
I. Condensation-Resistance Factor (CRF): Provide aluminum windows tested with window sash and ventilators closed and locked for thermal performance according to AAMA 1502.7, showing a CRF of less than 58.

J. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F, ambient; 180 deg F material surfaces.

2.3 ALUMINUM WINDOWS

A. Operating Types: Provide the following operating types in locations indicated on Drawings:

2. Fixed.


1. Thermally Improved Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.
2. Extruded aluminum shall be 6063-T5 alloy and temper.
3. Aluminum frame and sash extrusion shall have a nominal wall thickness of .094”.
4. Depth of frame and sash combined shall not be less than 3 ½”.
5. True divided light muntins shall be a maximum of 1 1/16” wide, with profiles to match architectural drawings.

C. Glass and Insulating Glazing Units:

1. As specified in Section 8 Glazing.

D. Glazing System: Manufacturer’s standard factory-glazing system that produces weathertight seal.

E. Hardware, General: Provide manufacturer’s standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.

1. Exposed Hardware Color and Finish: As selected by Architect from manufacturer’s full range.

F. Window Hardware:

1. Gear-Type Rotary Operators: Complying with AAMA 901 when tested according to ASTM E 405, Method A. Provide operators that function without requiring the removal of interior screens or using screen wickets.
   a. Casement Ventilators:
1) Standard: Roto operators, casement locking handles and precision machined aluminum 5 knuckle butt hinges with nylon bushings and stainless steel pins.

2. Hinges: Non-friction type, not less than two per sash.

3. Limit Devices:
   a. Limit clear opening to 8 inches for ventilation; with custodial key release.

G. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated. Weatherstrip to be Monsanto Santoprene or equal.

H. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.
   1. Exposed Fasteners: Do not use exposed fasteners to the greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

2.4 ACCESSORIES

A. Subsills: Thermally broken, extruded-aluminum subsills in configurations indicated on Drawings.

B. Interior Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.

C. Panning Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.

2.5 INSECT SCREENS

A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.
   1. Type and Location: Full, inside for project-out sashes.

B. Aluminum Frames: Manufacturer's standard aluminum alloy complying with SMA 1004 or SMA 1201. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.
   1. Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.

C. Aluminum Wire Fabric: 18-by-16 mesh of 0.011-inch- diameter, coated aluminum wire.
   1. Wire-Fabric Finish: Finish as selected from Manufacturer’s full range of standard and optional colors.

2.6 FABRICATION

A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

B. Glaze aluminum windows in the factory.
C. Weather strip each operable sash to provide weathertight installation.

D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

E. Provide water-shed members above side-hinged sashes and similar lines of natural water penetration.

F. Mullions: Provide mullions and cover plates, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design wind loads of window units.

G. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. High-Performance Organic Finish (Three-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitve primer and fluoropolymer color topcoat containing not less than 50 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.

1. Color and Gloss: Match Architect's sample
2. Number of Colors: Two.
3. One color will match curtain wall.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.

C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E 2112.

B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

D. Separate aluminum and other corrodefible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 ADJUSTING, CLEANING, AND PROTECTION

A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

B. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

1. Keep protective films and coverings in place until final cleaning.

C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

D. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

3.4 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
   1. Separate tempered glass waste for use as aggregate of nonstructural fill.

C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 08 51 13
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Fire rated glass floor system.
      1. Rating: 60 minutes.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal-framed glass floor system.
   B. LEED Submittals:
      1. Product Data for Credit IEQ 4.1: For sealants used inside the weatherproofing system, documentation including printed statement of VOC content.
   C. Shop Drawings: For metal-framed glass floor systems. Include plans, elevations, sections, details, and attachments to other work.
      1. Include details of provisions for assembly expansion and contraction and for draining moisture within the assembly to the exterior.
      2. Include full-size isometric details of the following:
         a. Joinery including concealed welds.
         b. Anchorage.
         c. Expansion provisions.
         d. Glazing.
         e. Flashing and drainage.
   D. Samples for Initial Selection: For units with factory-applied color finishes.
   E. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
   F. Fabrication Sample: Of each framing intersection of assemblies, made from 12-inch (305-mm) lengths of full-size components and showing details of the following:
      1. Joinery including concealed welds.
      2. Anchorage.
      5. Flashing and drainage.
   G. Delegated-Design Submittal: For metal-framed glass floor system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Engineer to be licensed in the Commonwealth of Pennsylvania.
1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and Testing Agency.

B. Welding certificates.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for metal-framed glass floor system.

D. Field quality-control reports.

E. Warranties: Sample of special warranties.

F. Closeout Submittals: Provide manufacturer’s maintenance instructions that include recommendations for periodic cleaning and maintenance of all components.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with minimum documented experience of five completed projects in the past 10 years.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of metal-framed skylights required for this Project.

1. Installer to be company specializing in performing work of this section with minimum documented experience of five completed projects in the past 10 years, and approved by manufacturer.

C. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.

D. Product Options: Information on Drawings and in Specifications establishes requirements for glass floor system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including testing conducted by an independent testing agency and in-service performance.

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

F. Provide a metal-framed glass floor system that complies with test-performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard assemblies by a qualified independent testing agency.

G. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical metal-framed glass floor system as directed by Architect.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

H. Preinstallation Conference: Conduct conference at Project site.
1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal-framed glass floor systems that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Noise or vibration caused by thermal movements.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      d. Adhesive or cohesive sealant failures.
      e. Water leakage.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Lite Floor glass floor system by Greenlite Glass Systems Inc., other pre-approved comparable product.

Greenlite Glass Systems, Inc.
2495 Davies Avenue, Unit 55
Port Coquitlam, BC
Canada V3C 0B2
Ph: 778.285.8530
E-Mail: info@greenliteglass.com
Web: www.greenliteglass.com

2.2 PERFORMANCE REQUIREMENTS

A. General: Metal-framed skylights shall withstand the effects of the following without failure due to defective manufacture, fabrication, installation, or other defects in construction:
   1. Structural loads.
   2. Thermal movements.
   3. Movements of supporting structure.
   4. Dimensional tolerances of support system and other adjacent construction.
   5. Failure includes, but is not limited to, the following:
      a. Deflection exceeding specified limits.
      b. Thermal stresses transferring to building structure.
      c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
      d. Glazing-to-glazing contact.
      e. Noise or vibration created by wind and by thermal and structural movements.
      f. Loosening or weakening of fasteners, attachments, and other components.
      g. Sealant failure.

B. Delegated Design: Design metal-framed skylights, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Structural Loads: Design glass floor system assemblies and attachments to resist the following loads:
   1. Floor Live and dead loads with L/500 of span maximum deflection.
      a. Live Loads: 100 psf (4.8 kPa) uniform load and concentrated load of 300 psf (14.4 kPa).
      b. Dead Loads: Actual weight of materials incorporated into Work.
2. Seismic Loads: As calculated in accordance with applicable code.

D. Thermal Movements: Provide metal-framed glass floor system that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.3 METAL FRAMED GLASS FLOOR WINDOWS

A. System Description:
1. Steel support framing requires four sided steel support as primary and secondary support. Steel support is mild steel rolled hollow sections protected with intumescent paper and ceramic tape. Primed and painted with intumescent paint for fire rated systems.
2. Double Glazed Panel System: Glass panels are double glazed structural glass on the upper surface and fire resistant glass below for fire rated systems suitable for indoor or outdoor IGU system applications.
3. Glass floor systems combine the fire rated glass and structural glass into a single steel frame protected by intumescent paint.

B. Double Glazed Panel System: Double glazed indoor or outdoor IGU rated panels.
3. Panel Size: Glass panels up to:
   a. 1500 mm by 1500 mm
   b. 1000 mm by 2000 mm.
4. Structural Glass:
   a. Glass construction: Three layers of heat strengthened glass laminated together using two layers of 0.76 mm or 1.52 mm polyvinyl butyrate, as manufactured by Saint-Gobain Eckelt & Co or equivalent. Transparent, translucent, or colored interlayer options to be chosen by Architect from standard range.
   b. Insulated Glass Units with Galvanized Steel Spacer bars and Polyisobutylene sealant.
   c. Glass thickness: Nominally 33 mm thick comprising 3 by 10 mm heat strengthened sheets laminated together, or 1 by 6 mm heat strengthened top sheet glass with 2 by 12 mm lower sheets subject to final design parameters.
   d. Surface Finish: Slip-resistant Frit Top surface of uppermost sheet to have approximately 30 to 50 percent coverage, as determined by project and architectural requirements. Eckelt Litefloor anti-slip ceramic frit in standard pattern or slip-resistant acid-etched top surface Eckelt LITEFLOOR EXT range of patterned acid-etch glass. Slip resistance co-efficient will be determined in accordance with ASTM F 1679.
   e. Pattern & Color of Frit as selected by architect from full range of manufacturer’s standard and premium colors and patterns.
   f. Design Loading: As specified.
5. Fire-Resistant Glass: Contraflam as manufactured by Vetrotech Saint-Gobain North America, Auburn, WA 98001
   a. Rating: 60 minutes, thickness 20.76 mm.
6. Steel Support Beam Assembly: Liteflam Frame consists of the load transfer steel support system together with blah paper, intumescent paper and intumescent paint.
7. Assembly:
   a. Glass supported on steel frame shall deflect no more than L/500 under the specified loading. Minimum edge support for the glass panels is 20 to 30 mm.
   b. Sealant Seals between panel and edge to be constructed using two-part polysulphide sealant in standard color as specified in Section 07900.
   c. Bedding Strip: Bedding strip between glass and supporting steelwork to be 60 shore hardness continuous silicone strip in standard color. Minimum bedding thickness shall be 5 mm.
8. Test Certification: Fire performance of load-bearing glass floor/ceiling assembly has been tested in accordance with ASTM E 119, "Standard test methods for fire tests of building construction and materials".

2.4 FABRICATION

A. Fit and shop assemble in largest practical sections, for delivery to site and field bolted assembly.

B. Fabricate components with joints tightly fitted and secured.

C. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

D. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

E. Prepare steel component surfaces in accordance with SSPC SP 6.

F. Shop prime and paint steel members. Do not prime surfaces that will be in contact with concrete, or high strength bolted.
   1. Finish paint with white Intumescent paint.
   2. Color top coat to be provided as selected by the Architect.

G. Supply steelwork to site with intumescent paint protection provided up to base coat level only. Final decorative finish coat to be applied on site after installation of steelwork is completed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Verify field measurements are as shown on shop drawings.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install components plumb and level, accurately fitted, free from distortion or defects.

C. Allow for erection loads, and for sufficient temporary bracing to maintain platform safe, plumb, and in alignment until completion of erection and installation of permanent bracing.

D. Make field connections with threaded fasteners.

E. Install panels on frames with full bearing.
F. Do not field cut or alter structural members without approval of Architect and glass floor system manufacturer.

G. After erection, touch up abrasions to match shop finishes.

H. Field finish components as specified in Division 09 Section “Interior Painting.”

3.4 FIELD QUALITY CONTROL

A. Bolted Connections: Inspect in accordance with AISC specifications.
   1. Visually inspect all bolted connections.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
   1. Water-Spray Test: Before installation of interior finishes has begun, metal framed glass floor system shall be tested according to AAMA 501.2 and shall not evidence water penetration.

C. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.

D. Additional testing and inspecting, at Contractor’s expense, will be performed to determine compliance of replaced or additional work with specified requirements.

E. Prepare test and inspection reports.

3.5 PROTECTION

A. Protect installed products until completion of project.

B. Do not permit traffic over unprotected floor surface.

C. Touch-up, repair or replace damaged products before Substantial Completion.

3.6 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
   1. Separate tempered glass waste for use as aggregate of nonstructural fill.

C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 08 64 00
SECTION 08 71 00 - FINISH HARDWARE   [C]

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

A. Definition: "Finish Hardware" includes items known commercially as finish hardware which are required for swing, sliding and folding doors, except special types of unique and non-matching hardware specified in the same section as the door and door frame.

B. Extent of finish hardware required is indicated on drawings and in schedules.

C. Types of finish hardware required include the following:
   1. Butt Hinges
   2. Continuous Hinges
   3. Lock cylinders and keys
   4. Lock and latch sets
   5. Exit devices
   6. Closers
   7. Electronic door control devices
   8. Overhead Holders
   9. Door trim units

1.3 RELATED SECTIONS

A. Division 8 - Steel Doors and Frames.

B. Division 8 - Flush Wood Doors.

C. Division 8 - Aluminum Doors and Frames

D. Division 16 – Electrical

1.4 QUALITY ASSURANCE

A. Manufacturer: Obtain each type of hardware (latch and lock sets, etc.) from a single manufacturer.

B. Supplier: A recognized architectural finish hardware supplier, with warehousing facilities, who has been furnishing hardware in the project's vicinity for a period of not less than 2 years, and who is, or who employs an experienced architectural hardware consultant who is available, at reasonable times during the course of the work, for consultation about project's hardware requirements, to Owner, Architect and Contractor.

C. Where emergency exit devices are required on fire-rated doors (with supplementary marking on doors with labels indicating "Fire Door to be Equipped with Fire Exit Hardware") provide labels on exit devices indicating "Fire Exit Hardware"
D. This supplier shall be responsible to field check existing openings for proper application of sizes and strikes for all openings.

1.5 REGULATORY REQUIREMENTS


B. Fire-Rated Openings: Provide hardware for fire-rated openings in compliance with NFPA Standard No. 80 and local building code requirements. Provide only hardware which has been tested and listed by UL or an approved testing agency for types and sizes of doors required and complies with requirements of door and door frame labels.

C. Fire-Rated Assemblies: Upon completion of the installation, all fire door assemblies shall be tested to confirm proper operation of the closing device and that it meets all criteria of a fire door assembly as per NFPA 80 2007 Edition. At completion of the project, written record shall be furnished by the door hardware supplier and given to the owner to be made available to the Authority Having Jurisdiction, “AHJ”. The record shall show all fire rated openings, door number and location, along with hardware supplied and installed for the opening. The inspection of the fire doors that are swinging doors with builders hardware type to be performed by individuals with knowledge and understanding of the operating components of the type of door being subjected to testing as required by the AHJ.

1.6 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data for each item of hardware in accordance with Division-1 section "Submittals”. Include whatever information may be necessary to show compliance with requirements, and include instructions for installation and for maintenance of operating parts and finish.

B. Hardware Schedule: Submit final hardware schedule in a vertical format as recognized by the Door and Hardware Institute (DHI). Horizontal schedule format will not be accepted. Coordinate hardware with doors, frames and related work to ensure proper size, thickness, hand, function and finish of hardware.

   1. Final Hardware Schedule Content: Based on finish hardware indicated, organize hardware schedule into “hardware sets” indicating complete designations of every item required for each door or opening. Include the following information:

   a. Type, style, function, size and finish of each hardware item.

   b. Name and manufacturer of each item.

   c. Fastenings and other pertinent information.

   d. Index to include location of hardware set cross-referenced to indications on drawings both on floor plans and in door and frame schedule.

   e. Explanation of all abbreviations, symbols, codes, etc., contained in schedule.

   f. Mounting locations for hardware.

   g. Door and frame sizes and materials.

   h. Keying information.

   i. Wiring diagrams with theory of operation.

C. Submittal Sequence: Submit schedule in accordance to Division 1, particularly where acceptance of hardware schedule must precede fabrication of other work (e.g., hollow metal frames) which is critical in the project construction schedule. Include with schedule the product data, samples, shop drawings of other work affected by finish hardware, and other information essential to the coordinated review of hardware schedule.
D. Keying Schedule: Submit separate detailed schedule indicating clearly how the Owner’s final instructions on keying of locks has been fulfilled.

E. Samples if Requested: Prior to submittal of the final hardware schedule and prior to final ordering of finish hardware, submit one sample of each type of exposed hardware unit, finish as required, and tagged with full description for coordination with schedule.

F. Templates: Furnish hardware templates to each fabricator of doors, frames and other work to be factory-prepared for the installation of hardware. Upon request, check shop drawings of such other work, to confirm that adequate provisions are made for proper location and installation of hardware.

1.7 PRODUCT HANDLING

A. Tag each item or package separately, with identification related to final hardware schedule, and include basic installation instructions with each item or package.

B. Inventory hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.

C. Deliver individually packaged hardware items at the proper times to the proper locations (shop or project site) for installation.

D. Provide secure lock-up for hardware delivered to the project, but not yet installed. Control handling and installation of hardware items which are not immediately replaceable, so that completion of the work will not be delayed by hardware losses, both before and after installation.

PART 2 - PRODUCTS

2.1 SCHEDULED HARDWARE

A. Requirements for design, grade, function, finish, size and other distinctive qualities of each type of finish hardware is indicated in the Finish Hardware Data Sheet and Hardware Schedule at the end of this section. Products are identified by using hardware designation numbers of the following.

B. Manufacturer’s Product Designations:
   Butt Hinges: Ives
   Continuous Hinges: Ives
   Locksets: Schlage Lock Co.
   Cylinders: Best Lock Co. (No Substitutions)
   Exit Devices: Von Duprin (No Substitutions)
   Closers: LCN Closers (No Substitutions)
   Automatic Door Operators LCN Closers (No Substitutions)
   Overhead Holders: Glynn-Johnson
   Kickplates: Ives
   Threshold & Weatherstrip National Guard Products

2.2 MATERIALS AND FABRICATION

A. General:
   1. Hand of door: Drawings show direction of slide, swing or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.
2. Manufacturer's Name Plate: Do not use manufacturer's products which have manufacturer's name or trade name displayed in a visible location (omit removable nameplates), except in conjunction with required UL labels and as otherwise acceptable to Architect.

3. Manufacturer's identification will be permitted on rim of lock cylinders only.

4. Finish: All hardware finish shall match US26D unless otherwise indicated. Closer bodies, covers and arms shall be powder coated finish.

5. Lockset Design: Lever handle design shall be similar to “Danmark 615A” as manufactured by Schlage Lock Co.

6. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware which has been prepared for self-tapping sheet metal screws, except as specifically indicated.

7. Furnish screws for installation, with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of such other work as closely as possible, including "prepared for paint" in surfaces to receive painted finish.

8. Provide concealed fasteners for hardware units which are exposed when door is closed, except to extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work, except where it is not feasible to adequately reinforce the work. In such cases, provide sleeves for each thru-bolt or use sex screw fasteners.

9. Tools and Maintenance Instructions for Maintenance: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of finish hardware.

2.3 HINGES, BUTTS AND PIVOTS

A. Templates: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

B. Screws: Furnish Phillips flat-head or machine screws for installation of units, except furnish Phillips flat-head or wood screws for installation of units into wood. Finish screw heads to match surface of hinges or pivots.

C. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:

1. Steel Hinges: Steel pins.
4. Interior Doors: Non-rising pins.
5. Tips: Flat button and matching plug, finished to match leaves.
6. Number of hinges: Provide number of hinges indicated but not less than 3 hinges per door leaf for doors 90" or less in height and one additional hinge for each 30" of additional height.

D. Acceptable Manufacturers:

1. Ives
2. McKinney
3. Hager

E. Supplier shall be responsible for the correct hinge size to fit any existing frames or doors.

F. Furnish hinges in sizes and types as required by architect’s details to achieve maximum degree of opening.

2.4 CONTINUOUS HINGES
A. Hinge shall be a pinless assembly of three interlocking extrusions applied to the full height of the door and frame without mortising. The door leaf and jamb leaf shall be geared together for the entire length of the hinge and joined by a channel. Hinge knuckle shall be monolithic in appearance. Continuous hinge with visible knuckle separations are not acceptable. Vertical door loads shall be carried on minimum 3/4" acetal bearings through a full 180 degrees. The door leaf and jamb leaf shall have templated screw hole locations for future replacement needs. All heavy duty hinges (HD) shall have a minimum of 32 bearings for a 7' length.

B. Acceptable Manufacturers:
   1. Ives
   2. Hager Roton
   3. Select Products

2.5 LOCK CYLINDERS AND KEYING

A. General: Supplier will meet with Owner to finalize keying requirements and obtain final instructions in writing.

B. Review the keying system with the Owner and provide the type required (master, grandmaster or great-grandmaster), integrated with Owner's existing Best Lock Company system. If key pinning charts are required, owner to furnish charts to hardware supplier.

C. Furnish Best Lock Company removable core cylinders at all doors, keyed as directed by the owner.

D. Furnish temporary keyed cores for the construction period, and remove these when directed. The construction cores remain property of the supplier and shall be returned to the supplier when they are removed. Contractor shall install the permanent cores in the presence of the owner's representative.

E. Metals: Construct lock cylinder parts from brass/bronze, stainless steel or nickel silver.

F. Comply with Owner's instructions for masterkeying and, except as otherwise indicated, provide individual change key for each lock which is not designated to be keyed alike with a group of related locks.

G. Permanently inscribe each key and cylinder with Visual Key Control that identifies cylinder manufacturer key symbol, and inscribe key with the notation "DO NOT DUPLICATE".

H. Key Material: Provide keys of nickel silver only.

I. Key Quantity:
   1. Furnish 3 change keys for each lock.
   2. 5 master keys for each master system.
   3. 5 grandmaster keys for each grandmaster system.
   4. One extra blank for each lock.
   5. 3 Control Keys (Construction and Permanent).
   6. 6 Construction master keys.

J. Deliver keys as directed by the owner.

K. Key Control System: Provide a key control system including envelopes, labels tags with self locking clips, receipt forms, 3-way visible card index, and standard metal cabinet, with a capacity for 150% of the number of locks required for this project.
   1. Key cabinet and system shall be provided as a part of this contract by the hardware supplier. Cabinet shall be indexed and set up by supplier with the owner's representative.
2.6 LOCKS, LATCHES AND BOLTS

A. Locks shall meet these certifications:
   1. Mortise Locks – ANSI A156.13, 1994, Grade 1 Operational, Grade 2 Security, ANSI/ASTM F476-76 Grade 30, UL listed. Levers shall be forged brass, bronze, or cast stainless steel, 93 lever design extruded brass, bronze or stainless steel. Meets A117.1 Accessibility Codes. Steel Case with ¾” throw stainless steel anti-friction latchbolt and a 1” throw stainless steel deadbolt. Lock case shall be field reversible, without opening the lock chasis and universal chasis to accept bith knob and lever functions. Lock trim shall incorporate individual lever support springs in each rose or escutcheon. Lever connection by attaching threaded bushings tightened by a spanner wrench. Threaded set screws will not be accepted. Lock spindles shall be two independent inside and outside spindles to prevent manipulation of lock. Strikes: Provide manufacturer’s standard wrought box strike for each latch or lock bolt, with curved lip extended to protect frame.
      a. Lock design shall be Schlage L9000 series Danmark 615A design – Finish to be 626.

B. Comply with UL requirements for throw of bolts and latch bolts on rated fire openings.

C. Lock Manufacturers: Subject to compliance with requirements, provide lockset products of the following approved manufacturers:
   1. Schlage Lock Co. “L9000 Series”
   2. Best Lock Co. “45H Series”
   3. Sargent Lock Co. “8200 Series”

D. Flush Bolt Heads: Minimum of 1/2” diameter rods of brass, bronze or stainless steel, with minimum 12” long rod for doors up to 7’-0” in height. Provide longer rods as necessary for doors exceeding 7’-0” in height.

E. Provide dust-proof strikes for foot bolts, except where special threshold construction provides non-recessed strike for bolt.

2.7 CLOSERS AND DOOR CONTROL DEVICES

A. Size of Units: Except as otherwise specifically indicated, comply with the manufacturer’s recommendations for size of door control unit, depending upon size of door, exposure to weather and anticipated frequency of use.

B. Closers: All door closers shall be of one manufacturer to provide for proper installation and servicing after installation. All closers shall be inspected after installation by a factory representative to ensure proper adjustment and operation. A report shall be filed with the architect after said visit has been made. Closer shall carry a manufacturer’s TEN YEAR WARRANTY for hydraulic units and 2 year warranty for electrical and/or handicap power assist door closers against manufacturing defects and workmanship.

C. Cylinder: Shall be of high strength cast iron construction. All door exterior closers shall be tested to ANSI/BHMA A156.4 test requirements by a BHMA certified independent testing laboratory. A written certification showing successful completion of a minimum of 10,000,000 cycles for all exterior door closers must be provided.

D. All door closers shall be fully hydraulic and have full rack and pinion action with a shaft diameter of a minimum of 11/16” and piston diameter of 1-1/2”. Closer shall utilize full complement bearings at shaft. Pinion and pistons shall be hardened regardless of closer size. The closer shall incorporate tamper resistant non-critical screw valves of V-slot design to reduce possible clogging. Closer shall have separate and independent screw valve adjustments for latch speed, general speed and
hydraulic backcheck. Backcheck shall be properly located so as to effectively slow the swing of the door at a minimum of 10 degrees in advance of the dead stop location.

E. Pressure relief valves are not acceptable.

F. All door closers shall pass UL10C positive pressure fire test.

G. Parallel Arm Closers: Shall incorporate one piece solid forged steel arms with bronze bushings. 1-9/16" x 1/2" steel stud shoulder bolts, shall be incorporated in regular arms, hold open arms, arms with stop built in, arms with hold open and stop built in. All other closers to have forged steel main arms for strength, and durability.

H. Built-In Stops: Where closers with built-in positive stops are used, the stops shall be of one piece cast malleable iron material. Screw on stops of any kind are not acceptable. Where required, the hold-open assembly handle for these stops shall rotate on ball bearings.

I. All closers to have a powder coat finish on closer body, arm, metal cover and adapter plate. Powder coat finish shall exceed a minimum 100 hour salt spray test, as described in ANSI Standard A156.4 and ASTM B117.

J. Hydraulic Fluid: All closers, with the exception of interior and interior electronic closers, shall utilize temperature stable fluid capable of withstanding temperature ranges of 120 degrees F. to -30F. without requiring seasonal adjustment of closer speed to properly close the door.

K. Supply all drop plates, shoe supports, spacers, templates, etc. to properly install closers according to manufacturer's recommendations.

L. Provide grey resilient parts for exposed bumpers.

M. Closer being submitted for approval shall have been manufactured for at least 10 years. A list of (10) year old projects using submitted closer shall be available upon request.

N. Closer Manufacturers: Subject to compliance with requirements, provide closer products of the following approved manufacturers:
   1. LCN Closers - 4010 / 4110 Series (No Substitutions)

2.8 ADA SPECIAL CLOSERS AND DOOR OPERATORS:

A. Were low kinetic energy, as defined by ANSI Standard A156.19, Surface mounted door operators shall be electric powered closers complying with the 1990 ADA requirements for opening force and time to closer standards. Full closing force shall be provided when the power or assist cycle ends.

B. Locate power unit exhaust away from door to minimize noise and vibration in pedestrian areas. Door operators shall be rack and pinion action with one piece forged steel pistons. Units shall be UL approved for fire labeled and non-labeled openings. Separate adjusting valves shall be provided for closing speed, latching speed and back check

C. Power operators systems shall include the following features and functions.
   1. Provisions for separate conduits to carry high and low voltage wiring, and shall be UL Listed for use on Fire Labeled Openings.

D. When obstruction or resistance to the opening swing is encountered, the operator will pause, then reattempt to open the door. If the obstruction or resistance remains, the operator will again pause the door.
E. Operators shall be designed to prevent damage to the mechanism if the system is actuated while the door is latched or if the door is forced closed during the opening cycle.

F. All parts shall be powder coated and successfully pass a minimum of 100 hours salt spray test, as outlined in ANSI Standard A156.18.

G. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work include:

1. LCN 4640 Auto-Equalizer Series (No Substitutions)

2.9 EXIT DEVICES

General: All devices and mullions shall be of one manufacturer to provide for proper installation and servicing. Devices shall be furnished non-handed and capable of direct field conversion for all available trim functions. All devices shall carry a three year warranty against manufacturing defects and workmanship. Exit device(s) being submitted for approval shall have been manufactured for at least 10 years. A list of (10) years old projects using submitted exit device shall be available upon request.

Furnish maintenance kit VonDuprin #050046 to owner at closeout of project.

Furnish mullion stabilizer similar to Von Duprin #154 for all mullions.

Furnish cylinders for all locking function exit devices.

Exit device shall be tested to ANSI/BHMA A156.3 test requirements by a BHMA certified independent testing laboratory. A written certification showing successful completion of a minimum of 1,000,000 cycles for surface and concealed vertical rod devices, 5,000,000 cycles for rim devices, and 10,000,000 cycles for mortise devices.

A. Surface Mounted / Concealed Vertical Rod Exit Devices:

1. Devices shall be push through type touch pad design with a straight or horizontal motion to eliminate pinch points. The angular motion type pad with end cavity exposed when depressed is unacceptable. Latch bolt shall have a self-lubricating coating which reduces friction and wear. Plated latch bolts are unacceptable. Device housing shall be heavy duty extruded aluminum.

2. Mechanism Case or Housing: Shall have an average minimum thickness of (.140") EXTRUDED aluminum, and shall have the adaptability to convert from standard hex key dogging to a high security cylinder dog operation in the field.
   a. No exposed screws shall be seen from the back side (pull side) of the device through a glass lite.
   b. The use of plastic parts to retract the latchbolt is unacceptable.

3. Springs: Only minimum (1/16") diameter compression springs are acceptable. All internal parts shall be zinc dichromate coated to prevent rusting.

4. Quiet Feature: All devices shall incorporate a hydraulic sound damper to which decelerates the touchpad on its return stroke and eliminates noise associated with exit device operation.

5. Touch Pad: Shall be architectural metal with a minimum height of 2-3/16". Plastic is not acceptable.

6. Outside Trim: Shall be heavy duty type and fastened by means of concealed welded lugs and thru-bolts from the inside. Lever trim shall be forged brass with a minimum average thickness on the escutcheon of (.130"). Plate with pull shall be minimum average thickness of (.090") and have forged pulls. Lever trim shall be furnished with “Break-Away Levers” (994L Trim).

7. End caps shall be sloped and of heavy-duty metal alloy construction and provide horizontal adjustment to provide flush alignment with device cover plate. When device end cap is installed, no raised edges will protrude. End cap shall be cast metal or forged aluminum and have a minimum thickness of (.250"). Plastic or metal stamping will not be acceptable.
8. All devices with US28 finish to have stainless steel touch bars with US26D trim.
9. All floor strikes on interior vertical rod panic devices to be similar to Von Duprin 385A.
10. Provide all shim kits and filler plates to allow flush mounting of exit devices on all types of doors used in this project.
11. Furnish all exit devices with deadlocking latchbolts.
12. Surface Vertical Rod Series Exit Device shall be tested to ANSI/BHMA A156.3 test requirements by a BHMA certified independent testing laboratory; a written certification showing successful completion of a minimum of 5,000,000 cycles must be provided by the independent laboratory. Rim Series Exit Device shall be tested to ANSI/BHMA A156.3 test requirements by a BHMA certified independent testing laboratory; a written certification showing successful completion of a minimum of 5,000,000 cycles must be provided by the independent laboratory. Mortise Series Exit Device shall be tested to ANSI/BHMA A156.3 test requirements by a BHMA certified independent testing laboratory; a written certification showing successful completion of a minimum of 10,000,000 cycles must be provided by the independent laboratory. Concealed Vertical Rod Series Exit Device shall be tested to ANSI/BHMA A156.3 test requirements by a BHMA certified independent testing laboratory; a written certification showing successful completion of a minimum of 1,000,000 cycles must be provided by the independent laboratory.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide exit device products of the following manufacturers:
   1. Von Duprin
   2. Sargent

2.10 DOOR TRIM UNITS

A. Fasteners: Provide manufacturer's standard exposed fasteners for door trim units (kick plates, edge trim, viewers, knockers, mail drops and similar units); either machine screws or self-tapping screws.

B. Fabricate protection plates (armor, kick or mop) not more than 1-1/2" less than door width on stop side and not more than 1/2" less than door width on pull side, x the height indicated. All protection plates shall have all edges beveled (B4E).

C. Metal Plates: Stainless steel, .050" (U.S. 18 ga.).

D. All pull plates and handles to be thru-bolted. Install pull plate prior to push plate to conceal thru-bolts. Provide concealed fasteners for all push/pull applications.

E. Acceptable Manufacturers:
   1. Ives.
   2. Rockwood
   3. Quality

2.11 WEATHERSTRIP AND GASKETING

A. General: Except as otherwise indicated, provide continuous weather stripping at each leaf of every exterior door. Provide type, sizes and profiles shown or scheduled. Provide non-corrosive fasteners as recommended by manufacturer for application indicated.

B. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips is easily replaceable and readily available from stocks maintained by the manufacturer.

C. Acceptable Manufacturers:
   2. Reese
3. National Guard Products

2.12 Thresholds

A. General: Except as otherwise indicated provide standard aluminum threshold unit of type, size and profile as shown or detailed.

B. Provide welded custom thresholds where scheduled and noted in the hardware sets. Provide cover plates where scheduled.

C. Provide thresholds that are 1" wider than depth of frame unless specified or detailed otherwise.

D. Acceptable Manufacturers:
   2. Reese
   3. National Guard Products

2.13 Door Silencers

All hollow metal frames shall have grey resilient type silencers. Quantity (3) on single doors and quantity (2) on pairs of doors.

2.14 Electrical Hardware

A. Where scheduled supply electrified exit devices that allow for remote retraction of latch bolts by use of a solenoid. Access control system will allow exit devices to be changed from exit only or latched to push-pull operation.

B. Furnish power transfers that are recessed into door and frame. Power transfers to allow electrical power to pass from door to frame without the use of door cords or transfer hinges.

C. Furnish power supplies to operate electrified exit devices. Power supplies to have regulated output that is field selectable for either 24VDC @ 2 amps or 12VDC @ 4 amps. Standard input at 120VAC @ 1amp or 240VAC @ 0.5amp. Power Supplies to have five (5) knockout holes for conduit connection with terminal block that handles up to 14 gauge wire. Power supplies will handle up to 16 amp current inrush to retract exit device latch bolt.

D. Furnish wiring diagrams (riser and point to point) with theory of operation to electrical contractor for use in installing electrical hardware products.

E. Electrical contractor to run all wiring and make all final connections for electrified hardware.

Hardware supplier shall be responsible to furnish all wiring diagrams to operate electrified hardware. Access control material and electrified hardware to interface at junction boxes.

Part 3—Execution

3.1 Hardware Schedule

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**BALANCE OF HARDWARE BY DOOR SUPPLIER**

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1 SET SEALS 5050B

HW SET: 14 [C]

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1 EA WALL STOP WS406CCV
3 EA SILENCER SR64 GRY

HW SET: 14A

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1 EA KICK PLATE 8400 10" X 2" LDW
1 EA WALL STOP WS406CCV
1 SET SEALS 5050B

HW SET: 15

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1 EA WALL STOP WS406CCV
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HW SET: 16

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1 EA MORTISE CYLINDER 1E74
1 EA SURFACE CLOSER 4111 EDA
1 EA KICK PLATE 8400 10" X 2" LDW
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**DOOR T217 TO HAVE TNS CORE.**

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**KEYSWITCH TO TURN ON/OFF ACTUATORS. ACTUATORS ONLY TO BE TURNED ON WHEN DOORS ARE MANUALLY DOGGED IN THE UNLOCK POSITION SO DOORS ACT IN A PUSH/PULL MANNER. AUTO-EQUALIZERS TO BE POWDER COATED SPECIAL COLOR TO MATCH FRAMES. OPERATORS TO BE WIRED FOR SEQUENTIAL OPERATION WITH DOOR F101. ACTUATOR LOCATED IN LOBBY TO OPERATE DOOR F101A AND F101 IN A TIME DELAY MANNER WITH THE VESTIBULE ACTUATOR TO OPEN DOOR F101A ONLY. ACTUATOR LOCATIONS TO BE DETERMINED BY THE ARCHITECT PRIOR TO ROUGH IN OF ELECTRICAL BOXES.**
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Henderson - Biobehavioral Health Building
DGS 800-290/PSU 06-42744/BCJ 08001  12 Nov 2010
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MOUNT Z ASTRAGAL ON STATIONARY DOOR AND PREP FOR ASA STRIKE. TWO DOORS TO BE USED AS STATIONARY BUT REMOVABLE PANELS VIA FLUSHBOLTS MOUNTED ON FACE OF TWO DOORS. WEATHERSTRIP TO BE MOUNTED ON ALL FOUR SIDES OF OPENING. ASTRAGALS TO BE MOUNTED WHERE PANELS MEET EACH OTHER.

HW SET: 32

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Use of doors will sound alarm. Keyswitch to turn on/off alarm.

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Card reader by others. Free egress at all times. Inside actuator always active and will retract latchbolt and open door. LX switch to allow outside actuator to be used when doors are electronically dogged. Presentation of valid card will retract latchbolts and allow use of outside actuator. Auto-equalizers to be powder coated to a special color to match frames. Operators to be wired for sequential operation with vestibule door. Exterior actuator to operate exterior door and inner vestibule door in a time delay manner with the interior vestibule actuator to open exterior door only. Actuator locations to be determined by the architect prior to rough in of electrical boxes.

HW SET: 36

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Use of doors will sound alarm. KEYSWITCH to turn on/off alarm.

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<td>8400 10&quot; X 1&quot; LDW</td>
<td>IVE</td>
</tr>
<tr>
<td>Seals</td>
<td>1</td>
<td>5050B</td>
<td>BRN NGP</td>
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**HW Set: 41**

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Quantity</th>
<th>Model/Brand</th>
<th>Finish</th>
</tr>
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<tbody>
<tr>
<td>Butt Hinges</td>
<td>3</td>
<td>5BB1WT 5 X 6</td>
<td>IVE</td>
</tr>
<tr>
<td>Store Room Lock</td>
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<td>L9080L DANMARK 615A X LESS OUTSIDE TRIM</td>
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<td>Mortise Cylinder</td>
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<td>1E74</td>
<td>BES</td>
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<td>ROC</td>
</tr>
<tr>
<td>Kick Plate</td>
<td>1</td>
<td>8400 10&quot; X 2&quot; LDW</td>
<td>IVE</td>
</tr>
<tr>
<td>Silencer</td>
<td>3</td>
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FINISH HARDWARE

08 71 00 - 21
## Hardware Set: 42

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Item Description</th>
<th>Part Number</th>
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<tbody>
<tr>
<td>1</td>
<td>Continuous Hinge</td>
<td>112HD 628 IVE</td>
</tr>
<tr>
<td>1</td>
<td>Panic Hardware</td>
<td>CD33A-NL-OP 626 VON</td>
</tr>
<tr>
<td>1</td>
<td>Rim Cylinder</td>
<td>1E72 626 BES</td>
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<tr>
<td>1</td>
<td>Mortise Cylinder</td>
<td>1E74 626 BES</td>
</tr>
<tr>
<td>1</td>
<td>SGL Dummy Trim</td>
<td>L0170 DANMARK 615A 630 SCH</td>
</tr>
<tr>
<td>1</td>
<td>Surface Closer</td>
<td>4111 EDA 689 LCN</td>
</tr>
<tr>
<td>1</td>
<td>Mounting Plate</td>
<td>4110-18 689 LCN</td>
</tr>
<tr>
<td>1</td>
<td>Blade Stop Spacing</td>
<td>4110-61 689 LCN</td>
</tr>
<tr>
<td>1</td>
<td>Overhead Stop</td>
<td>100S 630 GLY</td>
</tr>
<tr>
<td>1</td>
<td>Door Sweep</td>
<td>200NA AL NGP</td>
</tr>
<tr>
<td>1</td>
<td>Threshold</td>
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## Hardware Set: 43

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<tr>
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<tr>
<td>1</td>
<td>Continuous Hinge</td>
<td>112HD 628 IVE</td>
</tr>
<tr>
<td>1</td>
<td>SGL Dummy Trim</td>
<td>L0170 DANMARK 615A 630 SCH</td>
</tr>
<tr>
<td>1</td>
<td>Dummy Touch Bar</td>
<td>330 626 VON</td>
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<td>1</td>
<td>Surface Closer</td>
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</tr>
<tr>
<td>1</td>
<td>Mounting Plate</td>
<td>4110-18 689 LCN</td>
</tr>
<tr>
<td>1</td>
<td>Blade Stop Spacing</td>
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<tr>
<td>1</td>
<td>Overhead Stop</td>
<td>100S 630 GLY</td>
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<tr>
<td>1</td>
<td>Door Sweep</td>
<td>200NA AL NGP</td>
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<td>1</td>
<td>Threshold</td>
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## Hardware Set: 44

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<th>Quantity</th>
<th>Item Description</th>
<th>Part Number</th>
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<tbody>
<tr>
<td>2</td>
<td>Continuous Hinge</td>
<td>112HD 628 IVE</td>
</tr>
<tr>
<td>2</td>
<td>SGL Dummy Trim</td>
<td>L0170 DANMARK 615A 630 SCH</td>
</tr>
<tr>
<td>2</td>
<td>Dummy Touch Bar</td>
<td>330 626 VON</td>
</tr>
<tr>
<td>2</td>
<td>Auto-Equalizer</td>
<td>4642 REG SPL LCN</td>
</tr>
<tr>
<td>2</td>
<td>Overhead Stop</td>
<td>100S 630 GLY</td>
</tr>
<tr>
<td>2</td>
<td>Door Sweep</td>
<td>200NA AL NGP</td>
</tr>
<tr>
<td>1</td>
<td>Threshold</td>
<td>425 AL NGP</td>
</tr>
<tr>
<td>1</td>
<td>Actuator Package</td>
<td>8310-3857T LCN</td>
</tr>
</tbody>
</table>

Auto-Equalizers to be powder coated to a special color to match frames. Operators to be wired for sequential operation with exterior door. Interior actuator to operate vestibule door and exterior door in a time delay manner with the vestibule actuator to open interior vestibule door only. Actuator locations to be determined by the architect prior to rough in of electrical boxes.

**Miscellaneous Hardware to be Provided:**

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Item Description</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1</td>
<td>Maintenance Kit</td>
<td>050046 VON</td>
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<tr>
<td>1</td>
<td>Maintenance Equipment</td>
<td>Specialized tools and maintenance Instructions</td>
</tr>
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**Henderson - Biobehavioral Health Building**

**DGS 800-290/PSU 06-42744/BCJ 08001**

**12 Nov 2010**

**FINISH HARDWARE**

**08 71 00 - 22**
3.2 INSTALLATION

A. Mount hardware units at heights indicated in "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute, except as specifically indicated or required to comply with governing regulations, and except as may be otherwise directed by Architect.

B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way, coordinate removal, storage and reinstallation or application of surface protections with finishing work specified in the Division-9 sections. Do not install surface-mounted items until finishes have been completed on the substrate.

C. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

D. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

E. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant.

3.3 ADJUST AND CLEAN

A. Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application made.

B. Clean adjacent surfaces soiled by hardware installation.

C. Final Adjustment: Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

D. Instruct Owner's Personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.

E. Continued Maintenance Service: Approximately six months after the acceptance of hardware in each area, the Installer, accompanied by the representative of the latch and lock manufacturer, shall return to the project and re-adjust every item of hardware to restore proper function of doors and hardware. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures. Replace hardware items which have deteriorated or failed due to faulty design, materials or installation of hardware units. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware.

3.4 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
2. Plastic Materials
3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 08 71 00
SECTION 08 80 00 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Windows.
2. Doors.
4. Glazed entrances.
5. Sloped glazing.
6. Interior borrowed lites.

B. Related Sections:

1. Division 05 Section "Decorative Metal Railings" for glass panels in railings.
2. Division 08 Section “Stile and Rail Wood Doors.”
3. Division 08 Section “Glazed Aluminum Curtain Walls” for structural-sealant glazing requirements.
4. Division 08 Section “Aluminum Windows.”
5. Division 08 Section “Aluminum-Framed Entrances and Storefronts.”
6. Division 08 Section “Frameless Glass Doors & Storefront.”
7. Division 08 Section “Steel Fire Rated Glazed Curtain Wall.”
8. Division 08 Section “Mirrors.”

1.3 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Interspace: Space between lites of an insulating-glass unit.

1.4 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
B. Delegated Design: Design glass, including comprehensive engineering analysis according to ASTM E 1300, but not less than that required by ICC's 2006 International Building Code by a qualified professional engineer, using the following design criteria:

1. Design Wind Pressures: As indicated on Drawings.
2. Design Snow Loads: As indicated on Drawings.
3. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.
4. Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass to resist each of the following combinations of loads:
   a. Outward design wind pressure minus the weight of the glass. Base design on glass type factors for short-duration load.
   b. Inward design wind pressure plus the weight of the glass plus half of the design snow load. Base design on glass type factors for short-duration load.
   c. Half of the inward design wind pressure plus the weight of the glass plus the design snow load. Base design on glass type factors for long-duration load.
5. Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.008.
6. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/175 times the short-side length or 3/4, whichever is less.
7. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Testing will not be required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
2. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

1.6 ACTION SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. LEED Submittals:
1. Product Data for Credit IEQ 4.1: For glazing sealants used inside the weatherproofing system, documentation including printed statement of VOC content.

C. Glass Samples: For each type of the following products; 12 inches (300 mm) square.
   1. Coated glass.
   2. Fire-resistant glazing products.
   3. Laminated glass with colored interlayer.
   4. Insulating glass.

D. Glazing Accessory Samples: For gaskets, sealants and colored spacers, in 12-inch (300-mm) lengths.

E. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

F. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installers, manufacturers of insulating-glass units with sputter-coated, low-e coatings, glass testing agency and sealant testing agency.

B. Product Certificates: For glass and glazing products, from manufacturer.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for coated glass, insulating glass, glazing sealants and glazing gaskets.
   1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

D. Preconstruction adhesion and compatibility test report.

E. Warranties: Sample of special warranties.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.

B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Elastomeric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.
   1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
2. Test elastomeric glazing sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.

E. Preconstruction Adhesion and Compatibility Testing: Submit to elastomeric glazing sealant manufacturers, for testing indicated below, samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that will contact or affect elastomeric glazing sealants:

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
5. Testing will not be required if elastomeric glazing sealant manufacturers submit data based on previous testing of current sealant products for adhesion to, and compatibility with, glazing materials matching those submitted.

F. Source Limitations for Glass: Obtain coated float glass laminated glass and insulating glass from single source from single manufacturer for each glass type.

G. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

H. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.


I. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

J. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F (250 deg C), and the fire-resistance rating in minutes.

K. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

L. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Install glazing in mockups specified in Division 08 Section "Aluminum-Framed Entrances and Storefronts," "Aluminum Windows," and "Glazed Aluminum Curtain Walls" to match glazing systems required for Project, including glazing methods.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

M. Preinstallation Conference: Conduct conference at Project site.
   1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   2. Review temporary protection requirements for glazing during and after installation.

1.9 DELIVERY, STORAGE, AND HANDLING

   A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

   B. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 PROJECT CONDITIONS

   A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

      1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

1.11 WARRANTY

   A. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

      1. Warranty Period: Ten years from date of Substantial Completion.

   B. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

      1. Warranty Period: Ten years from date of Substantial Completion.
C. Manufacturer's Special Warranty for Ceramic Frit Coated-Glass Products: Manufacturer's standard form in which frit coated-glass manufacturer agrees to replace frit coated-glass units that deteriorate within specified warranty period. Deterioration of frit coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in frit coating.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.

1. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.

B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
2. For laminated-glass lites, properties are based on products of construction indicated.
3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.2 GLASS PRODUCTS

A. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.

B. Heat-Treated Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
2. For uncoated glass, comply with requirements for Condition A.
3. For coated vision glass, comply with requirements for Condition C (other coated glass).

2. Ceramic Coating Color: As selected by Architect from manufacturer's full range of standard and optional colors.
3. Ceramic Coating Pattern:

D. Ceramic-Coated Spandrel Glass: ASTM C 1048, Condition B, Type I, Quality-Q3, and complying with other requirements specified.

2. Ceramic Coating Color: As selected by Architect from manufacturer's full range of standard and optional colors.

2.3 LAMINATED GLASS

A. Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written recommendations.
   a. Where edges of laminated glass are indicated in the specifications or the drawings as exposed to the exterior, provide PVB interlayer suitable for exposure to exterior.

2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
3. Interlayer Color: Clear unless otherwise indicated.

B. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Laminated-Glass Types" Article.

2.4 INSULATING GLASS

A. Basis of Design Manufacturers: Subject to compliance with requirements and where indicated as a basis of design manufacturer in glazing types below, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. PPG Industries, Inc.

B. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.

1. Sealing System: Dual seal, with manufacturer's standard primary and secondary.
2. Spacer: Thermally broken stainless steel "warm edge" spacer in color selected by Architect from manufacturer's full range of standard and premium colors and finishes.
   a. Desiccant: Molecular sieve or silica gel, or blend of both.
   b. Corner Construction: Manufacturer's standard corner construction
   c. Basis of Design Product: Structural Warm-Light glass spacers, as manufactured by AZON USA, Inc, or approved equal.
3. Mechanically keyed spacer required in IGU's for structurally glazed curtain wall.
C. Glass: Comply with applicable requirements in "Glass Products" Article and in "Laminated Glass" Article as indicated by designations in "Insulating-Glass Types" Article and in "Insulating-Laminated-Glass Types" Article.

2.5 FIRE-PROTECTION-RATED GLAZING

A. Fire-Protection-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies and NFPA 257 for window assemblies.

B. Laminated Ceramic Glazing: Laminated glass made from 2 plies of clear, ceramic flat glass; 5/16-inch (8-mm) total nominal thickness; complying with testing requirements in 16 CFR 1201 for Category II materials.

1. Basis of Design Product: Subject to compliance with requirements, provide the following:
   a. Nippon Electric Glass Co., Ltd. (distributed by Technical Glass Products); FireLite Plus.
   b. Or approved equal.

2. To be used for fire rated door lights.

2.6 GLAZING GASKETS

A. Use only gaskets which glass manufacturers confirm are compatible with their products.

B. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
   1. EPDM complying with ASTM C 864.
   2. Silicone complying with ASTM C 1115.
   3. Thermoplastic polyolefin rubber complying with ASTM C 1115.

C. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned EPDM, silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.

1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

2.7 GLAZING SEALANTS

A. General:

   1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

   2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

   3. Sealants used inside the weatherproofing system, shall have a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range of standard and premium colors.

B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Dow Corning Corporation; 799.
   b. Or approved equal.

2. Confirm compatibility with interlayers of laminated glass.

3. Confirm compatibility with seals of insulated glass units.

C. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

2.8 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

   1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
   2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

   1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
   2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.9 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

G. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.10 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

2.11 MONOLITHIC-GLASS TYPES

A. Glass Type GL 5: ¼” Clear heat-strengthened float glass.
   1. Thickness: 6.0 mm.
   2. Visible light transmittance: 88%
   3. UV Transmittance: 63%
   4. Winter Nighttime U-Factor: 1.02 Btu/(hr x sqft x deg F) maximum
   5. Summer Daytime U-Factor: 0.92 Btu/(hr x sqft x deg F) maximum
   6. Solar Heat Gain Coefficient: 0.94 maximum.

B. Glass Type GL 5T: ¼” Clear fully tempered float glass.
   1. Thickness: 6.0 mm.
   2. Visible light transmittance: 88%
   3. UV Transmittance: 63%
   4. Winter Nighttime U-Factor: 1.02 Btu/(hr x sqft x deg F) maximum
   5. Summer Daytime U-Factor: 0.92 Btu/(hr x sqft x deg F) maximum
   6. Solar Heat Gain Coefficient: 0.94 maximum.
   7. Provide safety glazing labeling.

2.12 LAMINATED-GLASS TYPES

A. Glass Type GL 4: 1-1/4” Nominal Clear laminated glass with two equal plies of heat strengthened float glass.
   1. Thickness of each Glass Ply: 5/8”.
   2. Interlayer Thickness: 0.060 inch.
   3. Interlayer Type: PVB suitable for exterior exposure of glass edge.
   4. Visible Light Transmittance: 85 percent
   5. Ultra Violet Transmittance: less than one %
   6. Winter Nighttime U-Factor: 0.97 Btu/(hr x sqft x deg F) maximum
   7. Summer Daytime U-Factor: 0.88 Btu/(hr x sqft x deg F) maximum
   8. Provide safety glazing labeling.
10. Use: As indicated on the Drawings.

B. See Division 08 Section “Frameless Glass Doors & Storefront” for Laminated Glass types GL 7 and GL 8 to be used for frameless interior doors and partitions.

C. See Division 05 Section “Ornamental Railings” for Laminated Glass used for monumental stair railings, glass railings elsewhere in the building, and draft curtain glazing.

2.13 INSULATING-GLASS TYPES

A. Glass Type GL 1 and GL 1T: 1” Low-e-coated, clear insulating glass.
   1. Basis of Design: 1” IGU “Solarban 70XL Low-E Insulating Glass with Argon Gas as manufactured by PPG.
   2. Overall Unit Thickness: 1 inch.
   3. Thickness of Each Glass Lite: 6.0 mm.
   4. Outdoor Lite: Ultra-clear, low-iron Starphire, or approved equal; Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by the applicable Building Code and the CPSC safety glazing requirements.
   5. Interspace Content: Argon.
   6. Indoor Lite: Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by the applicable Building Code and the CPSC safety glazing requirements.
   7. Low-E Coating: Sputtered on second surface.
   8. Visible Light Transmittance: 64 percent minimum.
   9. Solar Energy Transmittance: 24%.
   10. Ultra Violet Transmittance: 6%.
   11. Winter Nighttime U-Factor: 0.24 Btu/(hr x sqft x deg F) maximum.
   12. Summer Daytime U-Factor: 0.21 Btu/(hr x sqft x deg F) maximum.
   13. Solar Heat Gain Coefficient: 0.27 maximum.
   14. Shading Coefficient: 0.31.
   15. Provide safety glazing labeling where applicable.
   16. Use: Typical pressure-plate curtain wall glazing and aluminum window glazing.

B. Glass Type 13 and 13T: 1 1/4” Low-e-coated, clear, tempered insulating glass for installation in structural glazed curtain wall system.
   1. Basis of Design: 1 1/4” IGU “Solarban 70XL Low-E Insulating Glass with Argon Gas as manufactured by PPG.
   2. Overall Unit Thickness: 1 1/4” inch.
   3. Thickness of Each Glass Lite: 6.0 mm.
   4. Outdoor Lite: Ultra-clear, low-iron Starphire, or approved equal; Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by the applicable Building Code and the CPSC safety glazing requirements.
   5. Interspace Content: Argon.
   6. Mechanically Keyed Spacer: Provide extruded aluminum desiccant filled u-channel spacer to accept Schuco structurally glazed system glazing clip, or approved equal that is compatible with glazing system selected.
   7. Indoor Lite: Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by the applicable Building Code and the CPSC safety glazing requirements.
   8. Low-E Coating: Sputtered on second surface.
   10. Solar Energy Transmittance: 24%.
   11. Ultra Violet Transmittance: 6%.
   12. Winter Nighttime U-Factor: 0.25 Btu/(hr x sqft x deg F) maximum.
   13. Summer Daytime U-Factor: 0.16 Btu/(hr x sqft x deg F) maximum.
14. Solar Heat Gain Coefficient: 0.27 maximum.
15. Shading Coefficient: 0.31.
16. Provide safety glazing labeling where applicable.
17. Use: Structurally glazed curtain wall.

C. Glass Type **GL 2 and GL 2T (Fritted):** 1" Clear, Ceramic coated, low e coated, insulated glass.
1. Basis of Design: Custom modification of 1" IGU “Solarban 70XL Low-E Insulating Glass with Argon Gas as manufactured by PPG.
2. Overall Unit Thickness: 1 inch.
3. Thickness of Each Glass Lite: 6.0 mm.
4. Outdoor Lite: Ultra-clear, low-iron Starphire, or approved equal; Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by the applicable Building Code and the CPSC safety glazing requirements.
5. Interspace Content: Argon.
6. Indoor Lite: Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by the applicable Building Code and the CPSC safety glazing requirements.
7. Low-E Coating: Sputtered on second surface.
8. Ceramic Dot Coating Silk Screen Pattern
   a. Location: No. 3 surface.
   b. Dot size: 1/8 inch diameter.
   c. Dot color: Medium gray.
   d. Pattern: 50% coverage
10. Solar Energy Transmittance: 24 percent.
11. Ultra-Violet Transmittance (300 to 380 nm): 6 percent.
12. Winter Nighttime U-Factor: 0.24 Btu/(hr x sqft x def F) maximum.
13. Summer Daytime U-Factor: 0.21 Btu/(hr x sqft x def F) maximum.
14. Solar Heat Gain Coefficient: 0.27 maximum.
15. Shading Coefficient: 0.31.
16. Provide safety glazing labeling where applicable.
17. Use: South wall glazing, including Southeast Conference Rooms.

D. Glass Type **14:** 1" Clear insulating glass with simulated acid etch.
1. Basis of Design: Custom modification of 1" IGU Solarscreen Insulating Glass as manufactured by Viracon.
2. Overall Unit Thickness: 1 inch.
3. Thickness of Each Glass Lite: 6.0 mm.
4. Outdoor Lite: Clear float glass.
5. Interspace Content: Air.
6. Indoor Lite: Clear float glass.
7. Low-E Coating: Sputtered on second surface.
8. Simulated acid etch coating: (Basis of Design) **V1085 screen #3058,** simulated acid etch, full coverage on second and third surface.
10. Interior windows in Offices 218, 311, 412 and entrance framing and doors in Classrooms 102, 102A.
11. Aesthetic Effect: The simulated acid etch product listed establishes the standard (texture, density, translucence) which must be met by any other product to be considered an acceptable equal.

2.14 INSULATING-LAMINATED-GLASS TYPES

A. Glass Type **GL 3:** 1" Low-e-coated, clear insulating laminated glass.
1. Basis of Design: Basis of Design: "Solarban 70XL Low-E Insulating Glass with Argon Gas as manufactured by PPG.
2. Overall Unit Thickness: 1”.
3. Thickness of Outdoor Lite: 6.0 mm.
4. Outdoor Lite: Ultra-clear, low-iron Starphire, or approved equal; Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by ICC's 2006 International Building Code and the CPSC safety glazing requirements.
5. Interspace Content: Argon.
6. Indoor Lite: Clear laminated glass with two plies of Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by ICC's 2006 International Building Code and the CPSC safety glazing requirements.
   a. Thickness of Each Glass Ply: 6.0 mm.
   b. Interlayer Thickness: 0.060 inch.
   c. Interlayer Type: Clear PVB.
7. Low-E Coating: Sputtered on second surface.
8. Visible Light Transmittance: 64 percent minimum.
10. Ultra-Violet Transmittance (300 to 380 nm): 0 percent.
11. Winter Nighttime U-Factor: 0.24 Btu/(hr x sqft x def F) maximum.
12. Summer Daytime U-Factor: 0.21 Btu/(hr x sqft x def F) maximum
13. Solar Heat Gain Coefficient: 0.27 maximum.
14. Shading Coefficient: 0.31.
15. Use: Skylight identified in Division 08 Section “Sloped Glazing.”

2.15 FIRE-PROTECTION-RATED GLAZING TYPES

A. Glass Type GL 6: 90-minute fire-rated glazing; laminated ceramic glazing.
   1. Provide safety glazing labeling.
   2. Use: Fire stair door vision lights.

B. See Division 08 Section “Steel Fire Rated Curtain Wall” for Glass Types GL 9, GL 10, GL 11 and GL 12 to be used in interior fire rated steel curtain walls and doors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
   1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
   2. Presence and functioning of weep systems.
   3. Minimum required face and edge clearances.
   4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.

2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

K. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
L. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.
3.6 **SEALANT GLAZING (WET)**

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 **LOCK-STRIP GASKET GLAZING**

A. Comply with ASTM C 716 and gasket manufacturer's written instructions. Provide supplementary wet seal and weep system unless otherwise indicated.

3.8 **CLEANING AND PROTECTION**

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.9 **WASTE MANAGEMENT**

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
   1. Separate tempered glass waste for use as aggregate of nonstructural fill.

C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
1. Aluminum
2. Plastic Materials and Gaskets
3. Corrugated cardboard packaging.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 08 80 00
SECTION 08 83 00 – MIRRORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following types of silvered flat glass mirrors:
   1. Annealed monolithic glass mirrors.

B. Related Sections:
   1. Division 06 Section "Interior Architectural Woodwork" for solid surfacing trim to be installed at mirror.
   2. Division 10 Section "Toilet & Shower Accessories" for metal-framed mirrors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.

C. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachments to other work.

D. Samples: For each type of the following products:
   1. Mirrors: 12 inches (300 mm) square, including edge treatment on two adjoining edges.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Certificates: For each type of mirror and mirror mastic, from manufacturer.

C. Preconstruction Test Reports: From mirror manufacturer indicating that mirror mastic was tested for compatibility and adhesion with mirror backing and substrates on which mirrors are installed.

D. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For mirrors to include in maintenance manuals.
1.6 QUALITY ASSURANCE

A. Installer Qualifications:  A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

B. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.

C. Glazing Publications: Comply with the following published recommendations:
   1. GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glass and glazing terms not otherwise defined in this Section or referenced standards.
   2. GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."

D. Safety Glazing Products: For film-backed mirrors, provide products complying with testing requirements in 16 CFR 1201 for Category II materials.

E. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing and substrates on which mirrors are installed.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.8 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Do not proceed with mirrored glass installation until ambient conditions of ventilation, temperature, and humidity will be continuously maintained at values near those indicated for final occupancy.
   2. Do not install mirrored glass over new masonry, plaster, or freshly painted walls without proper sealing.
   3. Do not install mirrored glass in construction areas while airborne solvents or heavy-duty cleaners are in the air.

B. Coordinate mirrored glass installation to occur after completion and lean-up of work by other divisions that might have detrimental effects on mirrors.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which mirror manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
   1. Warranty Period: Five years from date of manufacture.

PART 2 - PRODUCTS
2.1 SILVERED FLAT GLASS MIRRORS

A. Glass Mirrors, General: ASTM C 1503; manufactured using copper-free, low-lead mirror coating process.
   1. Manufacturers: Subject to compliance with requirements, including fabrication of custom cut sizes, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Arch Aluminum & Glass Co., Inc.
      b. Avalon Glass and Mirror Company.
      c. Binswanger Mirror; a division of Vitro America, Inc.
      d. D & W Incorporated
      e. Donisi Mirror Company.
      f. Gardner Glass, Inc.
      g. Gilded Mirrors, Inc.
      h. Guardian Industries.
      i. Head West.
      j. Independent Mirror Industries, Inc.
      k. Lenoir Mirror Company.
      l. Maran-Wurzell Glass & Mirror.
      m. National Glass Industries.
      n. Stroupe Mirror Co., Inc.
      o. Sunshine Mirror; Westshore Glass Corp.
      p. Virginia Mirror Company, Inc.
      q. Walker Glass Co., Ltd.

B. Clear Glass: Mirror Quality; ultraclear (low-iron) float glass with a minimum 91 percent visible light transmission.
   1. Nominal Thickness: 6.0 mm.

C. Tempered Clear Glass: Mirror Glazing Quality, for blemish requirements; and comply with ASTM C 1048 for Kind FT, Condition A, tempered float glass before silver coating is applied.
   1. Nominal Thickness: 6.0 mm.

2.2 MISCELLANEOUS MATERIALS

A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.

C. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Franklin International; Titebond Division.
      b. Laurence, C. R. Co., Inc.
      c. Macco Adhesives; Liquid Nails Division.
      d. OSI Sealants, Inc.
      e. Palmer Products Corporation.
      f. Pecora Corporation.
      g. Royal Adhesives & Sealants; Gunther Mirror Mastics Division.
      h. Sommer & Maca Industries, Inc.
   2. Adhesive shall have a VOC content of not more than 70 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
D. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

2.3 FABRICATION
A. Mirror Sizes: To suit Project conditions, cut mirrors to final sizes and shapes.
B. Mirror Edge Treatment: Flat polished.
   1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
   2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.
B. Verify compatibility with and suitability of substrates, including compatibility of mirror mastic with existing finishes or primers.
C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION
A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

3.3 INSTALLATION
A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
B. Provide a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.
C. Wall-Mounted Mirrors: Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
   1. Top and Bottom Aluminum J-Channels: Provide setting blocks 1/8 inch (3 mm) thick by 4 inches (100 mm) long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch (6.4 mm) wide by 3/8 inch (9.5 mm) long at bottom channel.
   2. Install mastic as follows:
      a. Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
      b. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
      c. After mastic is applied, align mirrors and press into place while maintaining a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface.
3.4 CLEANING AND PROTECTION

A. Protect mirrors from breakage and contaminating substances resulting from construction operations.

B. Do not permit edges of mirrors to be exposed to standing water.

C. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.

D. Wash exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash mirrors as recommended in writing by mirror manufacturer.

3.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
   1. Separate tempered glass waste for use as aggregate of nonstructural fill.

C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 08 83 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Fixed, extruded-aluminum louvers.
   2. Wall vents (brick vents).

1.3 PERFORMANCE REQUIREMENTS
A. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
   1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
   1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
   2. Show mullion profiles and locations.

1.5 QUALITY ASSURANCE
A. Source Limitations: Obtain louvers and vents from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

1.6 PROJECT CONDITIONS
A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.

B. Galvanized-Steel Sheet: ASTM A 653/A 653M, G60 zinc coating, mill phosphatized.

C. Fasteners: Use types and sizes to suit unit installation conditions.
   1. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
   2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
   3. For fastening galvanized steel, use hot-dip-galvanized steel or 300 series stainless-steel fasteners.

D. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
   1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern unless horizontal mullions are indicated.
   2. Horizontal Mullions: Provide horizontal mullions at joints unless continuous vertical assemblies are indicated.

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
   1. Frame Type: Interior flange unless otherwise indicated.

D. Include supports, anchorages, and accessories required for complete assembly.

E. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches o.c., whichever is less.
1. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.

F. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Drainable-Blade Louver:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Construction Specialties, Inc.
   b. Dowco Products Group; Safe-Air of Illinois, Inc.
   c. Greenheck Fan Corporation.
   d. Industrial Louvers, Inc.
   e. NCA Manufacturing, Inc.
   f. Ruskin Company; Tomkins PLC.

2. Louver Depth: 6 inches.
3. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
4. Mullion Type: Exposed.
5. Louver Performance Ratings:
   a. Free Area: Not less than 8.5 sq. ft. for 48-inch-wide by 48-inch-high louver.
   b. Point of Beginning Water Penetration: Not less than 900 fpm.
   c. Air Performance: Not more than 0.10-inch wg static pressure drop at 700-fpm free-area velocity.

6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

1. Screen Location for Fixed Louvers: Interior face.
2. Screening Type: Insect screening.

B. Secure screen frames to louver frames with machine screws with heads finished to match louver, spaced a maximum of 6 inches from each corner and at 12 inches o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same kind and form of metal as indicated for louver to which screens are attached.
2. Finish: Same finish as louver frames to which louver screens are attached.
3. Type: Rewirable frames with a driven spline or insert.
D. Louver Screening for Aluminum Louvers:

1. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.

2.5 BLANK-OFF PANELS

A. Insulated, Blank-Off Panels: Laminated panels consisting of insulating core surfaced on back and front with metal sheets and attached to back of louver.

1. Thickness: 2 inches.
2. Metal Facing Sheets: Galvanized-steel sheet, not less than 0.028-inch nominal thickness.
3. Insulating Core: Rigid, glass-fiber-board insulation or extruded-polystyrene foam.
4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard channel frames, with corners mitered and with same finish as panels.
5. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
6. Panel Finish: Same type of finish applied to louvers, but black color.
7. Attach blank-off panels with clips or sheet metal screws.

2.6 WALL VENTS (BRICK VENTS)

A. Extruded-Aluminum Wall Vents:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Construction Specialties, Inc.
   b. Dowco Products Group; Safe-Air of Illinois, Inc.
   c. Greenheck Fan Corporation.
   d. Industrial Louvers, Inc.
   e. Reliable Products, Inc.
   f. Ruskin Company; Tomkins PLC.

2. Extruded-aluminum louvers and frames, not less than 0.125-inch nominal thickness, assembled by welding; with 18-by-14-mesh, aluminum insect screening on inside face; incorporating weep holes, continuous drip at sill, and integral waterstop on inside edge of sill; of load-bearing design and construction.

3. Dampers: Aluminum blades and frames mounted on inside of wall vents; operated from exterior with Allen wrench in socket-head cap screw. Fabricate operating mechanism from Type 304 stainless-steel components.


2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.8 ALUMINUM FINISHES

A. Finish louvers after assembly.
B. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION
A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
C. Form closely fitted joints with exposed connections accurately located and secured.
D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
F. Protect unpainted galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 07 Section "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING
A. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.
B. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

D. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
   
1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 08 90 00
SECTION 08 90 10 – ARCHITECTURAL GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Fixed, extruded aluminum bar grate architectural grille in window stools.
   2. Aluminum door transom grille, stopped into interior aluminum frame.

B. Related Sections:
   1. Division 08 Section "Interior Aluminum Frames" for transom frames above doors to receive grille.
   2. Division 23 Sections for louvers that are a part of mechanical equipment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including finishing materials.

B. Shop Drawings: For grilles and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of metal finish required.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain louvers and vents from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

B. Powder-Coating Applicator Qualifications for Door Transom Grille: A firm experienced in successfully applying powder coatings of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
   1. Powder-Coat Finish on door transom grille to exactly match interior aluminum frame into which it is stopped.

C. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.


D. Fasteners: Use types and sizes to suit unit installation conditions.
   1. Use tamper-resistant screws for exposed fasteners unless otherwise indicated.
   2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
   3. For color-finished louvers, use fasteners with heads that match color of louvers.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
   1. Frame Type: Frameless, unless otherwise indicated.

D. Include supports, anchorages, and accessories required for complete assembly.

2.3 FIXED, EXTRUDED-ALUMINUM GRILLES

A. Horizontal, Sightproof, Grille:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Model A700 Aluminum No-Vision Door and Partition Grille as manufactured by A-J Manufacturing Co., or comparable product by one of the following:
      a. Air Balance Inc.; a Mestek company.
      b. Air Flow Company, Inc.
      c. Airolite Company, LLC (The).
      d. American Warming and Ventilating, Inc.; a Mestek company.
      e. Arrow United Industries; a division of Mestek, Inc.
      f. Cesco Products; a division of Mestek, Inc.
      g. Construction Specialties, Inc.
      h. Dowco Products Group; Safe-Air of Illinois, Inc.
      i. Greenheck Fan Corporation.
      j. Industrial Louvers, Inc.
      k. Ruskin Company; Tomkins PLC.
      l. United Enertech Corp.
   2. Grille Depth: 1 inch.
   4. Frame and Blade Nominal Thickness: 0.050 inch.
   5. Blade Spacing: ½ inch o.c.
   6. Free Area: 80%.
7. Frame Type: Minimal frame with no flange. Grille to be stopped into interior aluminum door frame transom opening. Grille frame shall not be visible after grille is installed.
8. Finish: Custom powder coat finish to exactly match Interior Aluminum Frame.
9. Number of Colors Required: One.

2.4 EXTRUDED ALUMINUM BAR GRATING ARCHITECTURAL GRILLES

A. Basis-of-Design Product: Subject to compliance with requirements, provide “KDAL Aluminum Grate” core material and accessories, as manufactured by Kadee Industries, Cleveland, Ohio, or comparable product by another manufacturer. Core material as follows:
   1. Tread Material: Architectural 6063-T6 extruded aluminum, 1.175” x .25” bars
   2. Tread Spacing: Standard Slot openings of .250”
   3. Core bar deflection angle: 0 degrees.
   4. Steel rod spacing: 10 inches on center.
   5. Assembly: Tread bars spaced with spacers and assembled with ¼” threaded steel rods and nuts.
   6. Fabricate for fastening: welded tabs as required for lockdown and to fasten core material to frame or substrate.
   7. Framing: 6063-T5 extruded aluminum.

B. Fabrication, General
   1. Provide hidden locking devices to prevent warping and rattling. Number of lockdowns shall be in accordance with manufacture’s recommendations for type and size of installation
   2. Core material welded wall panel sizes: 54-inches by twelve feet, or in sizes indicated.
   3. Shop fabricate core material to the greatest extent possible in sizes indicated.
   4. Fabricate cores for field joinery so that spacing of bars is consistent within and between core panels.
   5. Fabricate cores for field joinery for continuous appearance of linear bars at butt joints.
   6. Install black pencil screening at all grilles in a horizontal installation.
   7. Paint interior of ductwork behind grilles black.

C. Fabrication, Assembly, Frames and Mounting For Sill Installation
   1. Border subframe: Aluminum, finish to match core material.

D. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

2.5 BLANK-OFF PANELS

A. Uninsulated, Blank-Off Panels: Metal sheet attached to back of louver.
   1. Aluminum sheet for aluminum louvers, not less than 0.050-inch (1.27-mm) nominal thickness.
   2. Panel Finish: Same type of finish applied to louvers, but black color.
   3. Paint interior of ductwork behind grilles black.

2.6 FINISHES, GENERAL

A. Comply with NAAMM’s "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION
A. Locate and place grilles level, plumb, and at indicated alignment with adjacent work.
B. Use concealed anchorages where possible.
C. Form closely fitted joints with exposed connections accurately located and secured.
D. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers.
E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
F. Protect nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 07 Section "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING
A. Clean exposed surfaces of grilles that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
C. Restore grilles damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
   1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.
3.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 08 90 00
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SECTION 09 20 20 – ACOUSTICAL PLASTER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Work in this Section includes the following:
1. “Acoustical Plaster” shall include all labor, materials, equipment and services necessary to complete the seamless sound absorptive plaster system as shown on the drawings, and / or defined and specified herein. Acoustical plaster consists of manufacturer's standard, pre-coated mineral wool supporting panels, which are adhered to a stable substrate by others. The seams shall be filled with manufacturer’s Fill seam fill. A base coat and a finish coat, are applied onto the supporting panels on site, per manufacturer's specifications. The topcoat shall be troweled smooth to give the appearance of a smooth conventional plaster. The Acoustical Finish System is for reduction of reverberation time and is based on a fine porous surface that appears to be solid. The sound energy that enters through the pores is converted into heat. The work described in this Section, as shown on Drawings or as specified herein, shall be in accordance with the requirements of the Contract Documents

B. Related Sections include the following:
1. Division 05 Section "Cold-Formed Metal Framing" for load-bearing steel framing that supports gypsum board.
2. Division 07 Section "Joint Sealants" for acoustical sealants.
3. Division 09 Section "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board.
4. Division 09 Section "Gypsum Board" for interior gypsum board substrate for Acoustical Plaster system.

1.3 QUALITY ASSURANCE

A. Certified Installers:
1. At least 3 years experience installing the manufacturer’s Seamless Acoustical Finish System, employing supervisors and mechanics certified and approved by the manufacturer's North American Distributor.

B. New Installers:
1. New installers shall comply with all requirements of the manufacturer’s North American Distributor’s Certified Training Program, including, but not limited to, the purchase of approved manufacturer’s installation hand tools and equipment as well as contracting the services of at least one of Distributor’s full time on-site working Certified Trainer throughout the duration of the installation to ensure quality and compliance with all of the manufacturer’s details and other installation requirements.

1.4 SUBMITTALS

A. Shop Drawings / Product Data
1. Base Drawings, Approved Detail Drawings and Field Measurements.
2. Show dimensioned wall elevations or ceiling plans with joint locations, mounting details, transitions details to adjacent work, design, weight, thickness, color and other data necessary to install the work and coordinate work with other affected trades.

B. LEED Submittals:
   1. Credit EQ 4.1: Product data for sealants and sealant primers used inside the weatherproofing system, including printed statement of VOC content.
   2. Credit EQ 4.2: Product data for paints and coatings used inside the weatherproofing system indicating VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D.
   3. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.

C. Samples / Mock-Up
   1. Provide two 8-1/2” x 11” samples of the Acoustical Finish System in color as noted in section 2.1 D below.
   2. Job Site Mock-Up Area: Install mock-up of sound absorptive finish system. Obtain mock-up acceptance before any additional applications. Accomplish work to equal or exceed standard established by accepted job site mock-up.

D. Certification
   1. Acoustical Performance: Certified Acoustical Performance Sound Absorption Test Report data reports, conducted by a recognized, independent, testing agency shall be submitted upon request and meet the following minimum requirements. Sound absorption reports shall not be more than 3 years old. Noise Reduction Coefficient (NRC) for the 2.67” (68 mm) system shall be 0.85 as per ASTM C 423-07 Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method. Specific performance of the 2.67” seamless absorptive plaster system shall be as follows:

<table>
<thead>
<tr>
<th>Frequency, Hz</th>
<th>Absorption Coefficient</th>
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<tbody>
<tr>
<td>100</td>
<td>0.29</td>
</tr>
<tr>
<td>200</td>
<td>0.82</td>
</tr>
<tr>
<td>400</td>
<td>0.93</td>
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<td>5,000</td>
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</tbody>
</table>

   2. Fire Hazard: Evidence of compliance with regulatory agency and specification requirements.

1.5 REFERENCES


1.6 DELIVERY, STORAGE AND HANDLING
A. Allow materials to become acclimated to Project conditions before installation.
B. Ship and deliver in protective packaging to prevent freight damage.
C. Store materials in accordance with manufacturer's recommendations in a fully enclosed space where materials will be protected against damage from moisture, direct sunlight, surface contamination and other causes. All wet work must be completed in area of storage.
D. Protect Base 407 and Top from freezing.

1.7 PROJECT CONDITIONS
A. Environmental Requirements: Comply with requirements of referenced plaster application standards and recommendations of product manufacturer for environmental conditions before, during and after installation.
B. Cold Weather Requirements: When ambient outdoor temperatures are below 40 deg F, maintain a continuous uniform temperature of at least 50 deg F for at least 3 days before beginning of the material application, during its application and until material is dry, but for at least 7 days after application is complete. Distribute heat evenly; prevent concentrated or uneven heat from contacting material application near heat source.
C. Ventilation: Ventilate building spaces as required to remove excess moisture to promote drying of applied material.
D. Protect contiguous work form soiling, splattering, moisture deterioration and other harmful effects that may be caused by the application of the material.

PART 2 - PRODUCTS

2.1 MATERIALS

B. Installation shall be based upon the manufacturer’s Sound Absorptive Acoustical Finish System’s performance; specifications, information and details as supplied by the North American BASWAphon Distributor, Sound Solutions Construction Services, LLC, 3900 Ben Hur Ave., Suite 10, Willoughby, Ohio 44094 www.BASWAphonusa.com (440.951.6022 phone). Other products and installers must meet the exact design and performance criteria described herein. Substitutions only considered by written approval prior to bid.

C. Acoustical Plaster shall be provided in a total system thickness (adhesive, pre-coated mineral wool panels, base coat and finish coat) of approximately 2.67”.

D. The Acoustical Plaster seamless absorption system shall consist of pre-coated Manufacturer’s standard mineral wool supporting panels, which are adhered to a stable substrate. The seams shall be filled with Manufacturer’s standard Fill seam fill. A base coat, BASWAphon 407 and a finish coat, BASWAphon Top is applied onto the supporting panels on site, per manufacturer's
specifications. The topcoat shall be troweled smooth to give the appearance of a smooth conventional plaster.

E. The base and finish coats shall be integrally colored by the addition of pigments provided by the North American Manufacturer’s Distributor, Sound Solutions Construction Services, LLC, 3900 Ben Hur Ave., Suite 10, Willoughby, Ohio 44094 (440.951.6022 phone).

F. Color shall be custom color to match Architect’s sample.

G. Light Reflectance shall be 0.91 as per ASTM E1477-98a.

H. Flame Spread shall be Class A (I) per ASTM E-84.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas where and conditions under which Acoustical Plaster is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected to permit the proper installation of the work.

B. All substrates for the application shall not vary from plumb, level or “smooth consistent curvature” more than 1/4 inch in 12 feet.

C. Verify that all mechanical and electrical services within area of application have been tested, approved, and operable prior to commencement of application.

3.2 INSTALLATION

A. Install materials in accordance with the manufacturer’s instructions and details. Installation shall start only after all other work in the area of the installation has been completed.
1. Install a field applied adhesive layer 3-mm thick, using adhesive and methods in accordance with manufacturer’s installation instructions to the Manufacturer’s standard 63-mm thick Pre-Coated panels and adhere panels to stable substrate. Ensure that panels are set as level and as smooth to each other as practicable.
2. Install Manufacturer’s standard Trims with approved adhesives and cover with Pre-Coat.
3. Fill seams with Manufacturer’s standard Pre-Fill, sand Pre-Fill on panel seams and Pre-Fill on Manufacturer’s standard Trim completely smooth when dry.
4. Apply a 1.5-mm thick layer of Manufacturer’s standard Base-Coat 407, trowel smooth, sand completely smooth when dry.
5. Apply a 0.5-mm thick layer of Manufacturer’s standard Top-Coat and trowel smooth to a quality level consistent with accepted samples or mock-up. Note that Acoustical Plaster is a hand troweled finished product. Inherent in all hand troweled product applications, minor trowel marks in the finished surface may occur. Critical lighting may expose minor trowel marks inherent in all hand troweled products. The finish should be viewed under end-use lighting conditions.
6. Apply finish coat to both gwb ceiling and acoustical plaster ceiling in room to provide matching texture/finish.

3.3 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 09 20 20
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes: Gypsum board shaft wall assemblies.

1.3 ACTION SUBMITTALS
   A. Product Data: For each component of gypsum board shaft wall assembly.
   B. LEED Submittals:
      1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
      2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.

1.4 INFORMATIONAL SUBMITTALS
   A. Evaluation Reports: For shaft wall assemblies, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.6 FIELD CONDITIONS
   A. Environmental Limitations: Comply with ASTM C 840 requirements or with gypsum board manufacturer's written recommendations, whichever are more stringent.
   B. Do not install interior products until installation areas are enclosed and conditioned.
   C. Do not install panels that are wet, moisture damaged, or mold damaged.
      1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
      2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS
2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

A. Fire-Resistance Rating: 2 hours.

B. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.
   1. Depth: as indicated.
   2. Minimum Base-Metal Thickness: 0.033 inch.

C. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches long and matching studs in depth.
   1. Minimum Base-Metal Thickness: Matching steel studs.

D. Firestop Tracks: Provide firestop track at head of shaft wall on each floor level.

E. Room-Side Finish: Gypsum board, unless otherwise indicated.

F. Shaft-Side Finish: As indicated.

G. Insulation: Sound attenuation blankets.

2.3 PANEL PRODUCTS

A. Recycled Content of Gypsum Panel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 20 percent by weight.

B. Regional Materials: Gypsum panel products shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

C. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

D. Gypsum Shaftliner Board, Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with paper faces.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. American Gypsum; Shaft Liner.
      b. CertainTeed Corp.; ProRoc Shaftliner.
      d. Lafarge North America, Inc.; Firecheck Type X Shaftliner.
      e. National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner.
      f. PABCO Gypsum; Pabcore Shaftliner Type X.
      g. Temple-Inland Inc.; Fire-Rated SilentGuard Gypsum Shaftliner System.
      h. USG Corporation; Sheetrock Brand Gypsum Liner Panel.
   2. Thickness: 1 inch.
E. Gypsum Shaftliner Board, Moisture- and Mold-Resistant Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with moisture- and mold-resistant core and surfaces.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. CertainTeed Corp.; ProRoc Moisture and Mold Resistant Shaftliner.
      b. Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific; Dens-Glass Ultra Shaftliner.
      c. Lafarge North America, Inc.; Firecheck Moldcheck Type X Shaftliner.
      d. National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner XP.
      e. PABCO Gypsum; Pabcore Mold Curb Shaftliner Type X.
      f. Temple-Inland Inc.; Fire-Rated SilentGuard TS Mold-Resistant Gypsum Shaftliner System.
      g. USG Corporation; Sheetrock Brand Mold Tough Gypsum Liner Panel.
   2. Thickness: 1 inch.
   4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

F. Gypsum Board: As specified in Division 09 Section "Gypsum Board."

2.4 NON-LOAD-BEARING STEEL FRAMING

A. Recycled Content of Steel: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Steel Framing Members: Comply with ASTM C 645 requirements for metal unless otherwise indicated.

C. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Fire Trak Corp.; Fire Trak System.
      b. Grace Construction Products; FlameSafe FlowTrak System.
      c. Metal-Lite, Inc.; The System.
      d. Steel Network Inc. (The); VertiClip SLD or VertiTrack VTD Series.

2.5 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with manufacturer's written recommendations.

B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in Division 09 Section "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written recommendations for application indicated.

C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.

D. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
   1. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing according to ASTM E 488 conducted by a qualified testing agency.
2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing according to ASTM E 1190 conducted by a qualified testing agency.

E. Sound Attenuation Blankets: As specified in Division 09 Section "Gypsum Board."

F. Acoustical Sealant: As specified in Division 09 Section "Gypsum Board."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to which gypsum board shaft wall assemblies attach or abut, with Installer present, including hollow-metal frames, elevator hoistway door frames, cast-in anchors, and structural framing. Examine for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Sprayed Fire-Resistive Materials: Coordinate with gypsum board shaft wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft wall assemblies to comply with requirements specified in Division 07 Section "Applied Fireproofing."

B. After sprayed fire-resistive materials are applied, remove only to extent necessary for installation of gypsum board shaft wall assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.3 INSTALLATION

A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and ASTM C 754 other than stud-spacing requirements.

B. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.

   1. Reinforcing: Where handrails directly attach to gypsum board shaft wall assemblies, provide galvanized steel reinforcing strip with 0.033-inch minimum thickness of base metal (uncoated), accurately positioned and secured behind at least one layer of face panel.

C. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.

D. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels, while maintaining continuity of fire-rated construction.
E. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

F. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect while maintaining fire-resistance rating of gypsum board shaft wall assemblies.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.4 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, or mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

3.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 09 21 16
SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
   2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.
   3. Rated suspension system for ceiling.

B. Related Requirements:
   1. Division 05 Section "Cold-Formed Metal Framing" for exterior and interior non-load-bearing wall studs that are supporting brick or stone veneer.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
   1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
B. Studs and Runners: ASTM C 645.
1. Minimum Base-Metal Thickness: 0.033 inch typical; Provide deeper or heavier gauge studs wherever the unbraced height exceeds the stud capacity to meet L/240 deflection requirements with a 5 psf wall load.
2. Depth: As indicated on Drawings or 3-5/8 inches.

C. Slip-Type Head Joints: At all non-fire-rated partitions, provide one of the following:
1. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch-deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
2. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) Steel Network Inc. (The); VertiTrack VTD Series.
      2) Superior Metal Trim; Superior Flex Track System (SFT).

D. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Fire Trak Corp.; Fire Trak System attached to studs with Fire Trak Posi Klip.
   b. Metal-Lite, Inc.; The System.

E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
1. Minimum Base-Metal Thickness: 0.033 inch.

F. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness, with minimum 1/2-inch-wide flanges.
1. Depth: 1-1/2 inches.
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch-thick, galvanized steel.

1. Minimum Base-Metal Thickness: 0.033 inch.
2. Depth: 7/8 inch.

H. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission.
1. Configuration: Asymmetrical or hat shaped.

I. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges.
1. Depth: 3/4 inch.
2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch.
3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.

J. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 0.018 inch, and depth required to fit insulation thickness indicated.
2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

B. Hanger Attachments to Concrete:
   1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
      a. Type: Cast-in-place anchor, designed for attachment to concrete forms; Postinstalled chemical or expansion anchor permitted.
   2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch and minimum 1/2-inch- wide flanges.

E. Furring Channels (Furring Members):
   1. Cold-Rolled Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges, 3/4 inch deep.
   2. Steel Studs and Runners: ASTM C 645.
      a. Minimum Base-Metal Thickness: 0.033 inch.
      b. Depth: 3-5/8 inches.
      a. Minimum Base-Metal Thickness: 0.033 inch.
   4. Resilient Furring Channels: designed to reduce sound transmission.
      b. Size: as noted on the Drawings.

F. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      b. Chicago Metallic Corporation; Drywall Grid System.
      c. USG Corporation; Drywall Suspension System.

G. Resilient Suspended Ceiling Hanger System:
   1. Model: Kinetics Noise Control Model SRH-BBT Ceiling Hanger, or approved equal.
   2. Deflection Rating: One inch rated deflection.
   3. Construction: Rated deflection spring in series with a neoprene cup designed to resiliently support an STC rated ceiling assembly.
   4. Locations: Lecture Hall.
   5. Coordinate hanger mounting with adjacent construction.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.
   1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
B. Isolation Strip at Exterior Walls: Provide the following:
   1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
   1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

B. Coordination with Sprayed Fire-Resistive Materials:
   1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
   2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistant materials from damage.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.
   1. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
   2. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

B. Install studs so flanges within framing system point in same direction.
1. Space studs as follows:
   a. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
   b. Multilayer Application: 16 inches o.c. unless otherwise indicated.
   c. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.

C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
   a. Install two studs at each jamb unless otherwise indicated.
   b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
   c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
   a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated. Provide UL rated fire-resistive joint assembly in accordance with Division 07 Section “Fire-Resistive Joint Systems” to seal openings in metal deck above and around top track.
5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
6. Curved Partitions:
   a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
   b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.

D. Direct Furring:
1. Screw to metal framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:
1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
   a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
   a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Do not attach hangers to steel roof deck.
5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
7. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support as required to meet seismic requirements of authorities having jurisdiction.

F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

H. Sound-Rated Isolation Ceiling at Lecture Hall:
   1. Install framing for sound-isolating suspended GWB ceiling hung on specified spring hangers from structure above.
   2. Install suspension system such that framing members and supports are not in contact with ductwork, piping, conduit, adjacent structure or any other construction that would allow for the transfer of vibration from rooftop equipment above.

3.6 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers who take back waste for reuse or recycling.

END OF SECTION 09 22 16
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section includes interior decorative polished plaster finish system for installation over walls.
   B. Related Requirements:
      1. Division 09 Section “Gypsum Board Assemblies” for preparation of substrate.

1.3 REFERENCES

1.4 SYSTEM PERFORMANCE REQUIREMENTS
   A. Polished plaster system shall be tested by a qualified independent testing agency for the following properties according to the following test methods:
      1. Pencil Hardness: Minimum of 5H+ when tested in accordance with ASTM D3363.
      2. Scrub Resistance: Minimum 10,000 cycles using 10 grams of scrubbing medium and 5 grams of water applied by brush.

1.5 SUBMITTALS
   A. Product Data: Provide manufacturer’s technical data on products specified, including installation instructions.
   B. Shop Drawings: Indicate designs, colors, and locations.
   C. Samples: Submit 4 samples, 6 x 6 inches in size, illustrating finish color and texture.
   D. Qualification Data: Certificate issued by distributor indicating that installer has attended training class and is authorized to install specified product.
   E. Warranty: Sample copy of manufacturer's warranty stating obligations, remedies, limitations, and exclusions of warranty.

1.6 QUALITY ASSURANCE
   A. Installer Qualifications: Company specializing in performing work of this Section with a minimum of
one year documented experience. Include list of at least three completed projects of similar scope with project names and addresses and names and addresses of architects and owners. Installers must have attended the Polished Plaster manufacturer’s training class.

B. Single Source Responsibility: Provide a full system of only proprietary, factory-formulated materials as produced by the manufacturer specifically for applications indicated. Substitutes within the system are not permitted.

C. Fire-Test-Response Characteristics: Provide finished system with the following surface-burning characteristics as determined per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
   1. Flame Spread: 10 or less.
   2. Smoke Contribution: 10 or less.

D. Aesthetic Effect: The Basis-of-Design Product listed herein establishes not only performance standards but also aesthetic standards which must be met by any other product to be considered an acceptable equal.

1.7 MOCK-UP

A. Prior to installing polished plaster, construct mock-up of finished surface, 4 feet long by 8 feet wide, illustrating surface, finish and color.

B. Locate where directed by Architect.

C. Mockup shall remain in place until permanent installation is complete.

D. Mock-up may not remain as part of the Work.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the construction site in their original packaging with manufacturer’s labels identifying manufacturer and product; color designation; lot number; and date of manufacture.

B. Inspect materials upon delivery and immediately report to Architect damaged or defective materials.

C. Store materials in a well ventilated area with minimum ambient temperature of 45º F (7º C). Prevent deterioration due to moisture, temperature changes, contamination, or other causes.

1.9 PROJECT CONDITIONS

A. Environmental Requirements: Do not apply polished plaster when substrate or ambient air temperatures is under 45º F (7º C) or over 95º F (35ºC).

B. Maintain these conditions 24 hours before, during and after installation of polished plaster.

1.10 WARRANTY

A. Provide manufacturer’s standard written warranty.

B. Period of Warranty: 10 years.

PART 2 - PRODUCTS
2.1 MANUFACTURERS

A. Basis-of-Design Manufacturer: Armourcoat Ltd.; Morewood Close, London Road, Sevenoaks Kent. TH13 2HU. Tel: +44 (0) 1732 460668. Fax: +44 (0) 1732 450930. E-mail: sales@armourcoat.co.uk. Web: www.armourcoat.com.

2.2 PRODUCTS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Armourcoat Polished Plaster, Armourcoat Ltd., or a comparable product by an equivalent manufacturer.

B. Design: Single monolithic finish.

C. Finish: Smooth.

D. Color:
   1. Two (2) custom colors will be required, to match Architect’s samples.

2.3 MATERIALS

A. Polished Plaster System: Provide manufacturer’s complete system of proprietary materials specifically formulated for compatibility with one another and which may include primer, keycoat, resin, finish coat, and wax polish as required for designs, finishes, and colors specified.

B. Water: Clean, fresh, potable and free of mineral or organic matter which can affect plaster.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify the suitability of existing conditions before starting work. Do not begin Work of this Section until unsatisfactory conditions have been corrected.

B. Acceptable Substrate Tolerances: Verify that substrates are true and level. Substrates shall be constructed to the following tolerances:
   1. ± 0.05 inches in 2 feet and ± 0.15 inches in 6 feet.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for substrate preparation.

B. Remove hardware, electrical switch and outlet plates, lighting fixtures and other items already in place that are not to receive plaster finish.
   1. After completion of work, reinstall items using workers skilled in the trades involved.

C. Protect adjacent surfaces and items that are not to receive plaster finish, but which cannot be removed, from finish work. Use masking materials that will not damage protected items and surfaces.

D. Clean substrates of substances that could impair bond including mold, mildew, oil, grease, salts, contamination and dirt using methods recommended by manufacturer.

E. Substrate: For gypsum board substrates, apply coats of joint compound over joints and fasteners to achieve a minimum of a Level 4 finish. Use ready-mixed or job-mixed, drying-type, all-purpose or topping compound, or proprietary product specifically formulated for joint coating. Touch up and
sand as needed to produce a surface free of visual defects, tool marks, or ridges, and conforming to a smooth flat surface. Only apply Polished Plaster to Regular Gypsum Board that is fire resistant and complies with ASTM C 1396. Do not use moisture resistant Gypsum Boards.

F. Prepare all materials in accordance with manufacturer’s recommendations.

3.3 INSTALLATION

A. Prime Coat: Where recommended by manufacturer, apply prime coat. Allow to dry.

B. Keycoat: Where recommended by the manufacturer, mix and apply Keycoat in accordance with manufacturer’s instructions. Allow to dry.

C. Finish: Apply finish coats as recommended by manufacturer to achieve desired results. Number of coats and total dry mil thickness shall be as recommended by manufacturer for specified system. Allow to dry.

D. Wax: Apply wax to obtain sheen in accordance with manufacturer’s instructions using type of wax recommended by manufacturer for particular finish.

E. Provide finish free of unsightly variations in texture and other defects.

3.4 CLEANING AND PROTECTION

A. Remove temporary coverings used to protect adjacent surfaces and reinstall hardware, plates, lighting fixtures and other items previously removed.

B. Clean and repair adjacent surfaces and items soiled or damaged during Work of this Section.

C. Maintain and protect completed polished plaster surfaces until time of acceptance at Substantial Completion.

3.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 09 23 00
SECTION 09 29 00 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Interior gypsum board for painted finish.
   2. Reveal trims and other trim pieces for painted gypsum surfaces.
   3. Interior gypsum board substrate for polished plaster finish.
   4. Reveal trims and other trim pieces for polished plaster walls.
   5. Tile backing panels.
   7. Acoustic joint sealant.

B. Related Requirements:
   1. Division 06 Section "Sheathing" for gypsum sheathing for interior masonry veneer backup and exterior walls.
   2. Division 09 Section "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.
   3. Division 09 Section "Gypsum Board Shaft Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
   4. Division 09 Section "Polished Plaster" for polished plaster finish to be installed over substrate specified in this section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
   2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
   3. Product Data for Credit IEQ 4.1: For adhesives used to laminate gypsum board panels to substrates, documentation including printed statement of VOC content.

C. Samples: For the following products:
   1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.
1.4 QUALITY ASSURANCE

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
   1. All rated construction shall be continuous from concrete slab to underside of floor/deck above.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

C. Tolerances: For aluminum trim, tolerances shall be as follows:
   1. Horizontal plane: Variation from level shall be no more than 1/8 inch in 12 feet. Variation in plane of adjacent wallboard panels prior to joint treatment shall not exceed 1/16 inch prior to joint treatment.
   2. Framed vertical construction:
      a. Position: ¼ inch maximum variation from design position.
      b. Alignment: 1/8 inch in 8 feet maximum. ¼ inch maximum in any continuous wall, line or surface.
      c. Surface smoothness: No joint or fastener location, roughness or blemish discernible after application of finish when viewed at any angle from a distance of five feet under occupancy lighting conditions, with surface preparation as specified in Division 09 Section “Interior Painting.”

D. Mockups: Before beginning gypsum board installation, install mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Install mockups for the following:
      a. Each level of gypsum board finish indicated for use in exposed locations.
      b. Each reveal trim and molding specified.
   2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
   3. Simulate finished lighting conditions for review of mockups.
   4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Recycled Content of Gypsum Panel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 10 percent.

B. Regional Materials: Gypsum panel products shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

C. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Georgia-Pacific Gypsum LLC.
   3. USG Corporation.

B. Abuse-Resistant Gypsum Board: ASTM C 1629/C 1629M.
   1. Core: 5/8 inch, Type X, unless noted otherwise.
   2. Long Edges: Tapered.
   4. Locations: Typical, at all interior wall assemblies and interior face of exterior walls

C. Gypsum Wallboard: ASTM C 1396/C 1396M.
   1. Thickness: As indicated.
   2. Long Edges: Tapered.
   3. Locations: Where indicated.

D. Gypsum Board, Type X: ASTM C 1396/C 1396M.
   1. Thickness: As indicated.
   2. Long Edges: Tapered.
   3. Locations: Where indicated.

E. Flexible Gypsum Board: ASTM C 1396/C 1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.
   1. Thickness: 1/4 inch.
   2. Long Edges: Tapered.
   3. Locations: At radiusse walls.
F. Gypsum Ceiling Board: ASTM C 1396/C 1396M; Manufactured to have more sag resistance than regular-type gypsum board.
   1. Thickness: As indicated.
   2. Long Edges: Tapered.
   3. Locations: At all GWB ceiling areas, unless noted otherwise.

2.4 TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Board: ASTM C 1178/C 1178M, with manufacturer's standard edges.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Georgia-Pacific Gypsum LLC; DensShield Tile Backer.
   2. Core: 5/8 inch, Type X.

B. Water-Resistant Gypsum Backing Board: ASTM C 1396/C 1396M, with manufacturer's standard edges.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Georgia-Pacific Gypsum LLC.
      c. USG Corporation.
   2. Core: 5/8 inch, Type X.
   3. To be used on any wall surfaces in toilet rooms or janitor closets where a tile finish is not applied.
   4. Behind drinking fountains and on plumbing walls of coffee areas and work rooms with sinks.

2.5 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.
   1. Material: Galvanized Sheet Steel.
   2. Shapes:
      a. Cornerbead, with flanges punched and spackled in.
      b. U-Bead: J-shaped; exposed long flange receives joint compound.
      c. V-Control Joint: Expansion (control) joint.
      d. Curved-Edge Cornerbead: With notched or flexible flanges.

B. Aesthetic Effect: The Basis of Design Products listed herein establish not only performance standards, but also aesthetic standards which must be met by any other product to be considered an acceptable equal.

C. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
   1. Basis of Design Manufacturer: Subject to compliance with requirements, provide the products indicated below as manufactured by the Fry Reglet Corp. or Gordon, Inc., or a comparable product by one of the following:
      a. Fry Reglet Corp.
      b. Gordon, Inc.
      c. Pittcon Industries.
      d. MM Systems Corp.
   2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
   3. Finish:
      a. All other shapes: Manufacturer’s standard factory spray and bake-on primer to serve as base for field painting.
   4. Shapes Used with Polished Plaster:
a. Where indicated “1/2” Plaster Z Reveal Molding” in the Drawings, the Basis of Design product shall be Fry VPRZ-625-50.
b. Where indicated “Plaster Corner Key” in the Drawings, the Basis of Design product shall be Fry PCM-75-75.
c. Where indicated “L Trim Molding” in the Drawings, the Basis of Design product shall be Fry DRML-50.

5. Shapes Used with Acoustic Plaster:
a. Where indicated “Column Collar” in the Drawings, the Basis of Design product shall be Fry Reglet Column Collar, sized as indicated for specific column.

6. Shapes Used with GWB:
a. Where indicated “3/8” Z Reveal Molding” in the Drawings, the Basis of Design product shall be Fry DRMZ-625-375
b. Where indicated “Edge Cap Trim” in the Drawings, the Basis of Design product shall be Fry DMEC-200 where a 2” molding is shown, and Fry DMEC-3500 where a 3.5” molding is shown.
c. Where indicated “Projection Wall Edge” in the Drawings, the Basis of Design product shall be Gordon Final Forms I Shape 965-2125R.

7. End Caps: Provide end caps with or without flanges as is appropriate for the termination conditions of all reveal trim.

8. Fasteners: Exposed fasteners shall be counter sunk and shall match accessories in color.
a. Aluminum to aluminum: aluminum or Type 302 or 304 stainless steel.
b. Aluminum to stainless steel or carbon steel: Type 302 or 304 stainless steel.

9. Fabrication:
a. Mounting holes: provide mounting holes located 8 inches on center.
b. Make custom miters and intersections with welded corners or with high strength industrial tape on backs.

2.6 GWB GLAZING RETAINER TRIM

A. General:
1. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
2. Anchor trim to stud partition framing according to manufacturer’s recommendations, but not less than 8 inches on center.

B. Basis of Design: Subject to compliance with requirements, provide the following products by C.R. Laurence Co., Inc., or comparable product.
1. CRL ¼” Single ‘U’ Channel 5/8” High
2. CRL ¼” Single ‘U’ Channel 1-3/16” High
4. Provide manufacturer’s standard glazing gaskets.
5. Locations: Install in locations indicated on the Drawings.

2.7 SPRING-LOADED MULLION EXTENSION

A. General:
1. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
2. Anchor trim to stud partition framing according to manufacturer’s recommendations, but not less than 8 inches on center.

B. Basis of Design: Subject to compliance with requirements, provide the following products by Gordon, Inc., or comparable product.
1. Mullion Mate II: 4-11/16” min to 7-1/8” max opening.
2. STC 38.
3. Finish: Prefinish with same 3-coat system used on adjacent curtain wall; Color to match adjacent curtain wall.
4. Locations: Install in locations indicated on the Drawings.

2.8 GWB CHALKBOARD ACCESSORIES

A. General:
1. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
2. Anchor trim to stud partition framing according to manufacturer’s recommendations, but not less than 8 inches on center.

B. Basis of Design: Subject to compliance with requirements, provide the following products by Fry Reglet Architectural Metals, or comparable product.
1. Integrated Functional Reveal Rail – Provide where indicated in Drawings.
2. 2” Chartrail Insert – Provide where indicated in Drawings.
3. Hook Insert – Provide 10 hook inserts for each Integrated Functional Reveal Rail that is indicated to be installed at the top of a chalk board.

2.9 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:
1. Interior Gypsum Board: Paper.
2. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
3. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
   a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use drying-type, all-purpose compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.
5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.

D. Joint Compound for Tile Backing Panels:
1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
2. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.10 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer’s written recommendations.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.

C. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
2. Recycled Content of Blankets: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50% percent.

D. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Pecora Corporation; AC-20 FTR.
      b. USG Corporation; SHEETROCK Acoustical Sealant.
   2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation."

F. Vapor Retarder: As specified in Division 07 Section "Thermal Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
   1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
   2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch-wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.

J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer’s written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Single-Layer Application:
1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
   a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
   b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

B. Multilayer Application:
1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.
C. Curved Surfaces:
1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch-long straight sections at ends of curves and tangent to them.
2. For double-layer construction, fasten base layer to studs with screws 16 inches o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches o.c.

3.4 APPLYING POLISHED PLASTER SUBSTRATE

A. Prime Construction Considerations:
1. Applying Polished Plaster puts a lot of pressure on the substrate. Polished plaster does not shrink or crack on its own but being very hard, cracks in the substrate will penetrate through the finish.
2. 2-3 mm board joints filled with plaster are much more crack resistant than butted board joints.
3. Substrates must be dry. Dampness will affect the finish

B. Construction:
1. The wall shall be firmly constructed in metal stud partition which shall be vertically plumb and built to a true horizontal line without undulations, within strict tolerances:
   a. Plus or minus 1 mm in 600 mm
   b. Plus or minus 3 mm in 1.8 metres
2. All layers of substrate must be mechanically fixed to studs. The application of polished plaster involves the material being heavily trowelled as it is finished. The forces involved are much greater than normal plastering and will highlight any weaknesses in the substrate at the final stages.

C. Recommended Fixing Details for Plasterboard Walls in One and Two Layer Work:
1. Metal Frame Supports 0.55mm to 0.7mm – Use Gyproc Drywall Screws or equal
2. Metal Frame Supports 0.75mm to 2.5mm – Use Gyproc Jack-Point Screws or equal
3. Board Thickness: 12.5 mm
4. Length of Fixing Screws:
   a. First Board: 25mm
   b. Second Board: 38mm
5. Maximum Fastener Spacing: 300mm
6. Maximum Support Center Spacing: 600mm
7. For curved or circular walls, reduce support centers to 300mm.

D. Movement:
1. The walls when boarded out shall have no discernible movement when subjected to intermittent pressures (rocking) or impact.

E. Substrate Finishing: Taping & Jointing
1. **Jointing Boards Prior to Taping** Only jointing compounds approved by the board manufacturers shall be used to fill board joints, joint depressions, screw heads and any hammer or other impact marks. This operation shall be done in two applications; the first being allowed to set before the second is applied. Screw spotting shall be carried out between operations in the main jointing sequence. When filler is dry, sand down filler to remove snags and any unevenness before taping. With square edge boards cracking risks will be reduced by filling open joints (2-3mm) full depth with jointing compound. *

   *NOTE* A thin skim across close butting joints will simply bridge the board joint and predispose the surface to cracking.
2. **Taping and Jointing** Approved jointing tapes only shall be used. Armourcoat Limited recommends Gyproc joint tape applied in accordance with the manufacturer's recommendations. Ensure a clean surface free from dust or grease. Unroll tape centrally over filled joint pressing down firmly to ensure good adhesion. Apply a thin band of jointing compound 200 mm wide over and beyond each side of the tape and trowel flat. Make sure
the tape is firmly embedded with no air pockets. Using a jointing sponge, moisten the sponge and feather out the margins. Rinse sponge frequently to keep clean and soft. Obvious depressions in the surface can be filled again to correct surface flatness to the specified tolerances. When the sanding and filling process is complete and when the jointing compound is set and dry, lightly sand down the surface before applying a final layer of jointing compound 400-450mm wide feathered out either side of the tape avoiding any build over the tape run. Moisten the jointing sponge and feather out the edges. **NOTE** This dubbing out procedure, in successive thin coats, is required to take out the bump caused by taping the board joint. All other unevenness in the background shall be taken out in a similar way or by plastering overall with Thistle Multi-finish if flatness cannot be achieved by any other means. Jointing compounds, particularly along wallboard joints, shall be thoroughly dry before sealing. When wallboard surfaces are sealed before the jointing compounds are dry, polished plaster applications cannot proceed since the joint lines will grin through permanently disfiguring the finished work.

3. **Internal Corners** Armourcoat Limited recommends Gyproc tape. The gap 2-3 mm between corner boards shall be filled full depth with jointing compound. A thin layer of jointing compound is then applied to both sides of the arris. The joint tape is folded and pressed into the angle using a taping knife to bed the tape. Make sure that air bubbles are eliminated. There must be sufficient jointing compound left under the tape to ensure good adhesion. A thin layer of jointing compound 100 mm wide shall then be applied to each side of the arris. When this coat has set, another coat of jointing compound 300 mm wide shall be applied to both sides of the angle and the edges feathered out with a wetted sponge float or a damp sponge.

4. **Obtuse Angles** Armourcoat Limited recommends Gyproc corner-tape for obtuse angles. It is often difficult to produce a sharp straight line when forming an obtuse angle. By using Gyproc corner tape (zinc coated steel strips set on fibre paper) a good line can be formed where the directional change occurs. The procedure and sequence for fixing the tape and for finishing the surface of the plasterboard after fixing the tape is the same as in 2.1.10 but in this case feather out the plaster 600 mm either side of the arris.

5. **External Angles** With Armourcoat Polished Plaster applications a, choice of angle protection is available. (i) Gyproc Angle Bead (ii) SAS 90 Degrees High Strength Corners. **For corners where corner damage can be anticipated, consider pencil rounding the corners without beads or insert wood or metal end posts or cappings.** Gyproc angle bead and/or Truline angle bead affords optimum protection where a sharp external arris is specified but note comments regarding high-risk locations. Cut to the required length. Place the angle bead plumb over the external corner guarding against flaring top and bottom. Fix angle bead in approved manner. Apply a 200 mm wide 2 mm thick band of jointing compound to both sides and feather out the edges with a wetted sponge float or sponge. When set and dried, apply a second layer of jointing compound 400-450 mm wide to both sides of the angle and feather out the edges.

6. **Feature Beads** Thin coat plastering beads are available from British Gypsum Ltd (Tel 0800 225225), SAS – (Tel 0118 9290900) or QIC Trims (Tel: 01280 818 950). For detailing drawings please refer to the end of this document.

7. **Sealing Surface** All prepared wall surfaces shall be painted with an approved wallboard primer. Gyproc topcoat is approved by Armourcoat Limited. Before wallboard sealers are applied, the jointing compound must be thoroughly dry. Where wallboard surfaces are sealed before the jointing compounds are dry, polished plaster applications will be disfigured since dampness underneath the sealer will cause permanent shadow lines as the wall dries out. Similarly, shadow lines will arise at joint lines if surfaces are not sealed first.

3.5 **APPLYING TILE BACKING PANELS**

A. **Glass-Mat, Water-Resistant Backing Panels:** Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with 1/4-inch gap where panels abut other construction or penetrations.
B. Water-Resistant Backing Board: Install where indicated with 1/4-inch gap where panels abut other construction or penetrations.

C. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.6 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints at locations indicated on Drawings and according to ASTM C 840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:
   1. Cornerbead: Use at outside corners, spackled in.
   2. U-Bead: Use at exposed panel edges and reveals, spackled in.

D. Aluminum Trim: Install in locations where noted on the drawings, and any other similar circumstances shown on the drawings even if not specifically noted in every instance.
   1. Install trim in accord with manufacturer’s product data and as follows:
      a. Install 3/8” “GWB Z Reveal Molding” where GWB meets any other material such as brick, metal, slate, except,
      b. Do not install reveal trim in fire rated or in STC-rated partitions.
      c. Install with mechanical anchors spaced at 8 inches on center.
   2. Finish joints and attachment flanges with spackle, as described in this Section.
   3. Dust surfaces. Joint and fastener treatment shall be indistinguishable in finished work.
   4. Protect accessories from damage until date of Substantial Completion. Replace trim which may become damaged.

3.7 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
   1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
   2. Level 2: Panels that are substrate for tile.
   3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
      a. Primer and its application to surfaces are specified in other Division 09 Sections.
   4. Level 5: Lecture Hall projection wall to receive “Goo” paint finish, and where indicated on Drawings.
      a. Primer and its application to surfaces are specified in other Division 09 Sections.

E. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.
3.8 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

3.9 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers who take back waste for reuse or recycling.

END OF SECTION 09 29 00
SECTION 09 30 00 – TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Retain or delete this article in all Sections of Project Manual.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Ceramic tile.

B. Revise first two subparagraphs below if applicable only to thin-set applications.

C. Related Sections:
   1. Division 1 Section “Sustainable Design Requirements” for additional LEED requirements.
   2. Division 07 Section for waterproofing under thinset mortar beds at showers.
   3. Division 07 Section “Joint Sealants” for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
   4. Division 09 Section “Gypsum Board” for glass-mat, water-resistant backer board.
   5. Waterproof membrane. See Division 09 Section “Stone Flooring” for Waterproof Membrane.
   6. Crack isolation membrane. See Division 09 Section “Stone Flooring” for Crack Isolation Membrane.
   7. Division 09 Section “Stone Flooring” for stone thresholds.

D. LEED Opportunities: This Section has opportunities for the following LEED points:
   1. Materials and Resources Prerequisite 1 and Credits 2.1, 4.1, 4.2 and 5.1.
   2. Indoor Environmental Quality Credit 4.1.

1.3 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.


C. Module Size: Actual tile size plus joint width indicated.

D. Face Size: Actual tile size, excluding spacer lugs.
1.4 PERFORMANCE REQUIREMENTS

A. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:

1. Level Surfaces: Minimum 0.6.
2. Step Treads: Minimum 0.6.
3. Ramp Surfaces: Minimum 0.8.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
2. Credits MR 4.1 and MR 4.2: Product Data indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
   a. Include statement indicating costs for each product having recycled content.
3. Refer to Division 1 Section “Sustainable Design Requirements” for additional submittal requirements.

C. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

D. Samples for Initial Selection: For each type of tile and grout indicated. Include Samples of accessories involving color selection.

E. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required.
2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 12 inches square, but not fewer than 4 tiles. Use grout of type and in color or colors approved for completed Work.
3. Full-size units of each type of trim and accessory for each color and finish required.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

C. Product Certificates: For each type of product, signed by product manufacturer.

D. Material Test Reports: For each tile-setting and -grouting product and special purpose tile.
1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.8 QUALITY ASSURANCE

A. Source Limitations for Tile: Obtain tile of each type and color or finish from one source or producer.

1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:

2. Waterproof membrane. See Division 09 Section "Stone Flooring" for Waterproof Membrane.
3. Crack isolation membrane. See Division 09 Section "Stone Flooring" for Crack Isolation Membrane.

D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of each type of floor tile installation.
2. Build mockup of each type of wall tile installation.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
D. Store liquid materials in unopened containers and protected from freezing.

E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

F. Broken, cracked, chipped, stained, or damaged tile will be rejected.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2. Basis-of-Design Product: The design for each tile type is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard grade requirements unless otherwise indicated.

2. For face dimensions of tile, comply with requirements relating to tile sizes specified in Part 1 "Definitions" Article.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.
E. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.3 TILE PRODUCTS

A. Aesthetic Effect: The Basis of Design Products listed herein establish not only performance standards, but also aesthetic standards – sheen, texture, color range, dimension, etc. – which must be met by any other product to be considered an acceptable equal.

B. Tile Type-1: Glazed wall tile.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide “Veranda” as manufactured by Daltile or comparable product.
   2. Composition: Porcelain
   3. Module Size: 6 1/2 by 20 inch field tile; 3 by 20 inch decorative border.
   5. Face: Plain with square edges.
   7. Finish: Mat, clear glaze.
   8. Tile Color and Pattern: As selected by Architect from manufacturer's full range.
   9. Grout Color: As selected by Architect from manufacturer's full range.
  10. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
      a. Base shapes: Cove, module size 6 by 13, outside corner
      b. External Corners for Thin-Set Mortar Installations: Surface bullnose, same size as adjoining flat tile.
      c. Internal Corners: Field-butted square corners. For coved base and cap use angle pieces designed to fit with stretcher shapes.

C. Tile Type-2: Glazed paver tile (also used at shower wall).
   1. Basis-of-Design Product: Subject to compliance with requirements, provide “Natural Hues” as manufactured by Daltile or comparable product.
   2. Composition: Porcelain.
   3. Face Size: 4 by 4 inches.
   5. Face: Plain with square or cushion edges.
   6. Surface:
      a. Walls: Smooth, without abrasive admixture.
      b. Floor: Slip-resistant, with abrasive admixture.
   7. Finish: Mat, opaque or Mat, clear glaze.
   8. Tile Color and Pattern: As selected by Architect from manufacturer's full range.
   9. Grout Color: As selected by Architect from manufacturer's full range.
  10. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
      b. External Corners for Thin-Set Mortar Installations: Surface bullnose, module size 1 by 4 inches.
      c. Internal Corners: Round inside corner, 1 by 1 inch.
d. Trim: 3 3/4 x 7 3/4 inch

2.4 WATERPROOF MEMBRANE
A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
1. See Division 09 Section "Stone Flooring" for Waterproof Membrane.

2.5 CRACK ISOLATION MEMBRANE
A. General: Manufacturer's standard product selected from the following, that complies with ANSI A118.12 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
1. See Division 09 Section "Stone Flooring" for Crack Isolation Membrane.

2.6 SETTING MATERIALS
1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
2. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
4. Applications: TCA Installation Method F113 for floors and F122 for toilet room floor tile and W245 for wall tile, unless noted otherwise.

2.7 GROUT MATERIALS
A. Polymer-Modified Tile Grout: ANSI A118.7.
1. Polymer Type: Either ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients or Acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.
   a. Unsanded grout mixture for joints 1/8 inch and narrower.
   b. Sanded grout mixture for joints 1/8 inch and wider.

2.8 ELASTOMERIC SEALANTS
A. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Division 07 Section "Joint Sealants."
1. Use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use primers, backer rods, and sealant accessories recommended by sealant manufacturer.
B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.
C. One-Part, Mildew-Resistant Silicone Sealant: Install in accordance with Division 07 Section “Joint Sealants” for wall joints and Multi-Component Pourable Urethane Traffic Grade Sealant for floor expansion and control joints, in accordance with Division 07 Section “Joint Sealants.”

2.9 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.10 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers’ written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
   1. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
   2. Verify that concrete substrates for tile floors installed with thin-set mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
      a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
      b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
   3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
   4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.
B. Provide concrete substrates for tile floors installed with thin-set mortar that comply with flatness tolerances specified in referenced ANSI A108 Series of tile installation standards.
   1. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
   2. Remove protrusions, bumps, and ridges by sanding or grinding.

C. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.

D. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

E. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.3 TILE INSTALLATION

A. Comply with TCA's "Handbook for Ceramic Tile Installation" for TCA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
   1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
   2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
   3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

E. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

F. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
   1. As a minimum, provide sealant-filled movement joints in inside corners of walls, at changes in direction of tile in floors or walls, at changes from one type of ceramic or stone tile to another, and at all perimeter walls, columns and other obstructions.
   2. Locate movement joints at an even, regular spacing in open areas.
3. Limit the size of tile panels between movement joints to a ratio of length to width of approximately 1:1.5 or less, unless otherwise directed. Show all proposed locations and details for movement joints on Shop Drawings in accordance with the requirements of Part 1 of this Section.

4. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

5. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

G. Floor Tile Installation: Install tile to comply with requirements in the referenced TCA installation methods and ANSI A108 Series of the tile installation standards.
   1. For installations indicated below, follow procedures in ANSI A108 Series tile installation standards for providing 95 percent mortar coverage.
      a. Tile floors in wet areas.
      b. Tile floors composed of rib-backed tiles.

2. Joint widths: Install tile on floors with the following joint widths:

H. Ceramic Mosaic Tile: 1/16 inch

I. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
   1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in latex-portland cement mortar (thin set).
   2. Do not extend waterproofing under thresholds set in dry-set portland cement or latex-portland cement mortar. Fill joints between such thresholds and adjoining tile set on waterproofing with elastomeric sealant.

J. Grout tile to comply with requirements of the following tile installation standards:
   1. For ceramic tile grouts, comply with ANSI A108.10.

K. Grout Sealer: Apply grout sealer to cementitious grout joints in tile floors according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

L. Wall Tile Installation: Install types of tile designated for wall installations to comply with the requirements in the referenced TCA installation methods and ANSI setting-bed standards.
   1. Joint Widths: Install tile on walls with the following joint widths:
      a. Ceramic Mosaic Tile: 1/16 inch.

3.4 WATERPROOFING INSTALLATION

A. See Division 09 Section "Stone Flooring" for Waterproof Membrane.

3.5 CRACK ISOLATION MEMBRANE INSTALLATION

A. See Division 09 Section "Stone Flooring" for Crack Isolation Membrane.

3.6 CLEANING AND PROTECTING

A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
   1. Remove latex-portland cement grout residue from tile as soon as possible.
   2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by
testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.

B. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

D. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.

3.7 INTERIOR TILE INSTALLATION SCHEDULE

A. Interior Floor Installations, Concrete Subfloor:
   1. Tile Installation F113: Thin-set mortar; TCA F113.
      a. Tile Type: All floor tile.
      b. Thin-Set Mortar: Latex-portland cement mortar.
      c. Grout: Polymer-modified sanded grout.

B. Interior Wall Installations, Metal Studs or Furring:
   1. Tile Installation W245: Thin-set mortar on coated glass-mat, water-resistant gypsum backer board; TCA W245.
      a. Tile Type: all wall tile.
      b. Thin-Set Mortar: Latex- portland cement mortar.
      c. Grout: Polymer-modified unsanded grout.

3.8 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:

   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:

   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 09 30 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes
1. Acoustical panel ceilings.
2. Linear acoustical wood panel ceilings.
3. Exposed suspension systems for ceilings.
B. Related Requirements:
1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.
C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.
D. LEED Opportunities: This Section has opportunities for the following LEED points:
1. Materials and Resources Prerequisite 1 and Credits 2.1, 4.1, 4.2 and 5.1.
2. Indoor Environmental Quality Credit 4.1.

1.3 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. LEED Submittals:
1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
2. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
3. Product Data for MR Credit 7.0: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body. Include a statement indicating costs for each certified wood product.
C. Samples for Initial Selection: For components with factory-applied color finishes.
D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
1. Acoustical Panel: Set of full-size Samples of each type, color, pattern, and texture.
2. Exposed Suspension-System Members, Moldings, and Trim: Set of 12-inch- (300-mm-) long Samples of each type, finish, and color.
3. Linear acoustical wood panel ceilings.
1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Suspended ceiling components.
2. Structural members to which suspension systems will be attached.
3. Distinguish between areas to receive each type of acoustical panel ceiling.
4. Size and location of initial access modules for acoustical panels.
5. Items penetrating finished ceiling including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
6. Perimeter moldings.
7. Minimum Drawing Scale: 1/8 inch = 1 foot.

B. Shop Drawings: Provide Shop Drawings/Coordination Drawings for all ceilings, which should include RCP and product details. Coordinate Linear acoustical wood panel ceiling layout and installation of wood panels and suspension system components with other construction elements that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components, partition assemblies and all perimeter conditions.
1. Refer to Drawings for custom cantilevered edge detail at linear acoustical wood panel ceilings. This detail will require a mock-up for Architects review.

C. Qualification Data: For testing agency.

D. Product Test Reports: For each acoustical panel ceiling, for tests performed by a qualified testing agency.

E. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.

F. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Acoustical Ceiling Panels: Full-size panels equal to 2 percent of quantity installed.
2. Linear acoustical wood panel ceilings: Full-size panels equal to 5 percent of quantity installed, but not less than six panels.
3. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.
4. Hold-Down Clips: Equal to 2 percent of quantity installed.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to NVLAP for testing indicated.

B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Build mockup of each typical ceiling area as shown on Drawings.
2. Refer to Drawings for custom cantilevered edge detail at linear acoustical wood panel ceilings. Discuss size and location of mock-up with Architect.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, wood acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and stabilized moisture content.

C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use. Building areas to receive ceilings shall be free of construction dust and debris.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
   2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL PANELS, GENERAL

A. Aesthetic Effects: The Basis of Design Products listed herein establish not only performance standards but also aesthetic standards – texture, color, pattern, etc. – which must be met by any other product to be considered an acceptable equal.

B. Low-Emitting Materials: Acoustical panel ceilings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.

D. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.
E. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.
   1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface according to ASTM E 795.

F. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
   1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

G. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.3 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING ACT-1

A. Basis-of-Design Product: Subject to compliance with requirements, provide “Ultima” Ceiling System, as manufactured by Armstrong World Industries, Inc. or a comparable product.

B. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:
   1. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 2, water felted.

C. Color: White

D. LR: Not less than 0.90.

E. NRC: Not less than 0.70.

F. CAC: Not less than 33.

G. AC: N/A.

H. Edge/Joint Detail: Beveled Tegular, sized for 15/16-inch grid.

I. Thickness: 3/4 inch.

J. Modular Size: 24 by 24 inches

K. Antimicrobial Treatment: Surface treatment to inhibit growth of mold and mildew.

L. Humidity and Sag Resistant Treatment: HumiGuard Plus.

M. Recycled Content: 65% pre-consumer, 15% post-consumer.

N. Warranty: 10 year limited.

2.4 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING ACT-2, ACT-3 and ACT-4

A. Basis-of-Design Product: Subject to compliance with requirements, provide “Optima Open Plank” Ceiling System, as manufactured by Armstrong World Industries, Inc. or a comparable product.
B. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:
   1. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 2, water felted.

C. Color: White

D. LR: Not less than 0.90.

E. NRC: Not less than 0.70.

F. CAC: Not less than 33.

G. AC: N/A.

H. Edge/Joint Detail: Square Tegular, sized for 15/16-inch grid. (custom) [C]

I. Thickness: 1 inch.

J. Modular Size:
   a. ACT-2: 2 by 5 feet.
   b. ACT-3: 2 by 6 feet.
   c. ACT-4: 2 by 8 feet.

K. Antimicrobial Treatment: Surface treatment to inhibit growth of mold and mildew.

L. Humidity and Sag Resistant Treatment: HumiGuard Plus.

M. Recycled Content: 65% pre-consumer, 15% post-consumer.

N. Warranty: 10 year limited.

2.5 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING ACT-5 and ACT-6

A. Basis-of-Design Product System: Subject to compliance with requirements, provide the following panels for the integrated ceiling assemblies, “TechZone” Ceiling System, as manufactured by Armstrong World Industries, Inc. or a comparable product.


   1. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:
      a. Type and Form: Type XII, glass-fiber base with membrane-faced overlay; Form 2, cloth.
      b. Pattern: E (lightly textured).
   2. Color: White
   3. LR: Not less than 0.90.
   4. NRC: Not less than 0.95.
   5. AC: Not less than 190.
   7. Thickness: 1 inch.
   8. Modular Size:
      a. ACT-5: 33 by 24 inches. Custom size.
      b. ACT-6: 24 by 42 inches.


   1. Metal Technical Panels, powder coated, galvanized steel, unperforated.
   2. Technical Zone Technical panels accommodates recessed fixtures, linear air diffusers, sprinkler heads, and other components.
3. Size for both ACT-5 and ACT-6: 6 inch by 48 inch x .025”.
5. Edge detail: Square Tegular.
6. Thickness: 1 inch.

D. Humidity and Sag Resistant Treatment: HumiGuard Plus.
E. Recycled Content: 40%
F. Warranty: 10 year limited.

2.6 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING ACT-7

A. Basis-of-Design Product: Subject to compliance with requirements, provide “Ceramaguard” Ceiling System, as manufactured by Armstrong World Industries, Inc. or a comparable product.
B. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:
   1. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 2, water felted.
C. Color: White
D. LR: 0.82.
E. NRC: N/A.
F. CAC: Not less than 33.
G. AC: N/A.
H. Edge/Joint Detail: Square Lay-in sized for 15/16-inch grid.
I. Thickness: 5/8 inch.
J. Modular Size: 24 by 24 inches
K. Antimicrobial Treatment: Surface treatment to inhibit growth of mold and mildew.
L. Humidity and Sag Resistant Treatment: HumiGuard Plus.
M. Recycled Content: 65% pre-consumer, 15% post-consumer.
N. Warranty: 10 year limited.

2.7 LINEAR ACOUSTICAL WOOD PANEL CEILINGS

A. Basis-of-Design Product: Subject to compliance with requirements, provide “2100 Panelized Linear Wood” Ceiling System, as manufactured by 9 Wood, Inc. or a comparable product.
B. Wood Species: As selected by Architect. Plain sawn, solid Cherry [(Cherry (PS)]. FSC certified wood.
C. Member size: 5 1/4 by 3/4 inch.
D. Standard Panel Length: nominal 8 feet.
E. Edge Profile: Square.

F. Reveal: 3/4 inch, see Drawings

G. Members/LF: 5 members per linear foot

H. Assembly Style: “Panelized Linear”

I. Fire Rating: Class 1(A) Fire Rating


K. Reveal Scrim: “Gray reveal scrim”

L. Acoustical Backing: SoundTex (black) OR 1 inch Fiberglass (if Fiberglass is used for backing furring will be required to accommodate thickness in this application)

M. Backer/Cross Piece: 1 1/4 by 1/2 inch Gray or Black (to match scrim)

2.8 METAL SUSPENSION SYSTEMS, GENERAL

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.

C. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, “Direct Hung,” unless otherwise indicated. Comply with seismic design requirements.
   1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to six times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
      a. Type: Cast-in-place or Postinstalled bonded anchors.
      b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.

D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
   2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, “Direct Hung”) will be less than yield stress of wire, but provide not less than 0.135-inch- (3.5-mm-) diameter wire.

E. Hanger Rods or Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

F. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1-mm-) thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.

G. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

H. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
I. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in place.

J. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches (610 mm) o.c. on all cross tees.

2.9 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILING

A. Basis-of-Design Product: Subject to compliance with requirements, provide “Prelude standard 15/16 inch Exposed Tee System” as manufactured by Armstrong World Industries, Inc. or a comparable product.

B. Components: All main beams and cross tees shall be commercial quality hot-dipped galvanized (galvanized steel, aluminum, or stainless steel) as per ASTM A 653. Main beams and cross tees are double-web steel construction with type exposed flange design. Exposed surfaces chemically cleansed, capping pre-finished galvanized steel (aluminum or stainless steel) in baked polyester paint. Main beams and cross tees shall have rotary stitching (exception: extruded aluminum or stainless steel).
   2. End Condition of Cross Runners: Butt-edge type.
   3. Face Design: Flat, flush.
   5. Cap Finish: Painted white
   6. Provide shadow molding to match system as required.

2.10 METAL SUSPENSION SYSTEM FOR LINEAR ACOUSTICAL WOOD PANEL CEILINGS

A. Provide manufacturer’s standard metal suspension system compatible with 9Wood or equal exposed wood ceiling system.

2.11 METAL EDGE MOLDINGS AND TRIM, GENERAL

A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
   1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
   2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
   3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

   1. HCPA: 12-inch horizontal piece and VCPQ 12-inch vertical piece.
   2. Custom brake formed from .090 aluminum sheets.

C. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 for Alloy and Temper 6063-T5.

2. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.

3. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

   a. Organic Coating: Thermosetting, primer/topcoat system with a minimum dry film thickness of 0.8 to 1.2 mils.

5. Profile: As indicated in Drawings.

6. Provide fabricated corner units, where required.

7. Provide concealed splice plates to join where required.

2.12 EXTRUDED-ALUMINUM EDGE MOLDINGS AND TRIM FOR ACT-1 through ACT-7

A. Basis of Design Product: Subject to compliance with requirements, provide Axiom Classic Trim, Armstrong World Industries, or a comparable product.

B. Extruded Aluminum Edge Molding: Narrow vertical fin profile.
   1. Edge treatment: designed to produce ¼" perimeter reveal
   2. Depth: Manufacturer's nominal 2" Axiom Classic edge trim, with a vertical face dimension of 1 15/16".
   3. Colors: As selected by the Architect from the manufacturer's full range of custom colors.
   4. Install edge molding at perimeter of each pod, or at any location where ceiling does not extend to face of wall.

2.13 OTHER METAL EDGE MOLDINGS AND TRIM FOR GWB

A. Basis of Design Product: Subject to compliance with requirements, provide “Infinity D” as manufactured by Chicago Metallic or a comparable product.

   1. “Infinity D” 5/8 inch drywall ceilings, 8 inches high with 1” horizontal face taping flange grooved to accept joint compound. Panels to be as indicated on approved drawings. Outer surface to be primed for adhesion of joint compound and field applied paint finish.

B. Manufacturer's standard metal or extruded aluminum moldings for edges and penetrations, including light textures, that fit type of edge detail and suspension system indicated. Exposed edge flange to match face dimension of runner.

2.14 ACOUSTICAL SEALANT

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   1. Acoustical Sealant for Exposed and Concealed Joints:
      a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
      b. USG Corporation; SHEETROCK Acoustical Sealant.
   2. Acoustical Sealant for Concealed Joints:
      a. Henkel Corporation; OSI Pro-Series SC-175 Acoustical Sound Sealant.
      b. Pecora Corporation; AIS-919.
B. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
   3. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
   1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.

B. Suspend ceiling hangers from building's structural members and as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
   2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
   4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
   5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.

7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

8. Do not attach hangers to steel deck tabs.

9. Do not attach hangers to steel roof deck. Attach hangers to structural members.

10. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.

11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
   1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
   2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
   3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install exposed suspension system edge trim system in accordance with approved shop drawings and manufacturer's instructions.
   1. Keep hanger wires back from edge of “floating ceilings” such that hangers are concealed from view.

G. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
   1. Arrange directionally patterned acoustical panels as follows:
      a. As indicated on reflected ceiling plans.
      b. Install panels in a basket-weave pattern.
   2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
   3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with the top surface of runner flanges.
   4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom faces of runners.
   5. Re-tegular all cut edges of tegular ceiling tiles.
   6. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
   7. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions unless otherwise indicated.
3.4 INSTALLATION OF ACT-1 through ACT-7

A. Install suspension system and six-inch wide technical panels according to manufacturer's instructions.

3.5 INSTALLATION OF LINEAR ACOUSTICAL WOOD PANEL CEILINGS

A. General: Install 9Wood, Inc. Linear Acoustical Wood Panel Ceilings to comply with manufacturer's instructions and CISCA “Ceiling Systems Handbook”.

B. Refer to Drawings and approved Shop Drawings for custom cantilevered edge detail.

3.6 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

3.7 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 09 51 13
SECTION 09 63 40 - STONE FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following applications of dimension stone:
   1. Interior flooring.
   2. Stair treads.
   3. Thresholds.
   4. Slate window stools.

B. Related Sections:
   1. Division 04 Section "Stone Masonry" for exterior and interior stone veneer to match stone flooring.
   2. Division 04 Section “Stone Veneer Site Walls” for exterior and interior stone veneer to match stone flooring.
   3. Division 07 Section "Joint Sealants" for sealing control and expansion joints in stonework with elastomeric sealants.
   4. Division 32 Section "Unit Paving" for stone pavers to match interior stone flooring.

1.3 ACTION SUBMITTALS

A. Product Data:
   1. For each variety of stone.
   2. For stone accessories and other manufactured products.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.
   2. Product Data for Credit IEQ 4.3: For adhesives and grout, documentation including printed statement of VOC content.

C. Shop Drawings: Include plans, sections, details, and attachments to other work.

D. Samples for Initial Selection: For joint materials involving color selection.

E. Samples for Verification:
   1. For each stone type indicated, in sets of Samples not less than 12 inches square. Include four or more Samples in each set and show the full range of variations in appearance characteristics expected in completed Work. Samples will establish the standard by which stone will be judged.
   2. For each color of grout and pointing mortar required.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified fabricator.
1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For stone flooring to include in maintenance manuals. Include Product Data for stone-care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that custom fabricates stone.

B. Installer Qualifications: Stone fabricator.

C. Source Limitations for Stone: Obtain each variety of stone, regardless of finish, from a single quarry, whether specified in this Section or in other Sections of the Specifications, with resources to provide materials of consistent quality in appearance and physical properties.
   1. For stone types that include same list of varieties and sources, provide same variety from same source for each.
   2. Make quarried blocks available for examination by Architect for appearance characteristics.
   3. Make stone slabs available for Architect to examine for appearance characteristics.
      a. Architect will select aesthetically acceptable slabs and will indicate aesthetically unacceptable portions of slabs.
      b. Segregate slabs selected for use on Project and mark backs indicating approval.
      c. Mark and photograph aesthetically unacceptable portions of slabs as directed by Architect.

D. Source Limitations for Other Materials: Obtain each type of cementitious material, grout, admixture, stone accessory, and other material from single source.

E. Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockup of each type of stone flooring as directed by Architect.
   2. Build mockup of one typical stair tread, full width of final tread.
      a. Coordinate with the mockup of AESS steel for the Atrium monumental stair.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.

B. Store stone on wood A-frames or pallets with nonstaining separators and nonstaining, waterproof covers. Ventilate under covers to prevent condensation.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

1.8 PROJECT CONDITIONS

A. Cold-Weather Requirements for Interior Stone Flooring:
   1. Do not set stone when air or material temperature is below 50 deg F.
   2. Maintain temperature at 50 deg F or above in installation areas during installation and for 7 days after completion unless higher temperatures are required by fabricator's or supplier's instructions.
B. Cold-Weather Requirements for Exterior Stone Paving: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

C. Hot-Weather Requirements for Exterior Stone Paving: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602 and with the following:
   1. Maintain temperature of materials below 100 deg F.
   2. Do not apply mortar to substrates with temperatures of 100 deg F and above.
   3. When the ambient temperature exceeds 90 deg F, fog spray installed stone paving until damp at least 3 times a day until paving is 3 days old.

PART 2 - PRODUCTS

2.1 STONE

A. Products: Subject to compliance with requirements, provide stone of varieties and from sources complying with Division 04 Section “Stone Masonry” and Division 32 Section “Unit Paving.”

2.2 GRANITE

A. Granite: Comply with ASTM C 615.

B. Granite Type 1:
   2. Description: Uniform, fine-grained, gray stone with light veining.
   3. Stair Treads and Risers:
      a. Thickness: as indicated on the Drawings, both 1-1/4” and 2-1/4” stone will be used.
      1) Provide Thermal finish on tread and riser ends where exposed @ glass railing – see Drawings.
      c. Sizes: As indicated on Drawings.
   4. Flooring:
      a. Thickness: 1 1/4”.
      c. GF 1 -- Pattern 1 (typical) – 18” x 36”, 1/3 running bond
      d. GF 2 -- Pattern 2 (accent band along column line F and where indicated) – size and pattern as indicated on drawings: 4'-6” x 2'-0” U.O.N.
      e. GF 3 -- Pattern 3 – 20” x 36”, 1/3 running bond
      f. GF 4 – Pattern 4 (accent band along column lines B and D where indicated; also along column lines D.1 and A.7 on Level 1 only) – size and pattern as indicated on drawings
      g. GF 5 – Pattern 5 (Stair C landings where shown) – size as indicated on drawings
   5. Thresholds:
      a. Thickness: As indicated on schedules.
      b. Width: Width of threshold to match depth of door frame or wall unless otherwise indicated.
      c. Length: Full width of opening unless otherwise indicated.
   6. Match Architect’s samples for color, finish, and other stone characteristics relating to aesthetic effects.

C. Granite Type 2:
   1. Variety: “Southern Yellow Waterjet” as manufactured by Structural Stone, Inc., or equal.
   2. Tile:
a. Thickness: 3/8”.
b. Finish: Thermal.
c. GT -- Pattern 1 – Random size and pattern.
3. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.3 SLATE

A. Slate: Comply with ASTM C 629, Classification II Interior, with a fine, even grain and unfading color, from clear, sound stock.
2. Color: Unfading Black.
3. Stair Treads, Risers and Landing Flooring:
   a. Thickness: as indicated on the Drawings, both 1-1/4” thick and 2-1/4” thick slate will be used.
   b. Finish: Honed.
   c. Sizes: As indicated on Drawings.
4. Tile Type 1:
   a. Thickness: 3/8”.
   b. Finish: Honed.
   c. ST 2 -- Pattern 2 (accent band along column line F and where indicated) – size and pattern as indicated on drawings: 8” x 16” typ running bond U.O.N.
   d. ST 3 -- Pattern 3 (flooring at top and bottom landings of Stair C and where indicated) – size and pattern as indicated on drawings: 8 1/2” x 18” typ thin joint U.O.N.
5. Tile Type 2:
   a. Finish: Natural Cleft.
   b. ST 4 -- Pattern: as shown on Drawings: 6” X 16” typ, 1/3 running bond.
   c. ST 5 -- Pattern: accent band @ column lines B & D where indicated: 8” x 16” typ running bond U.O.N.
6. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
7. Thresholds:
   a. Thickness: As indicated on schedules.
   b. Width: Width of threshold to match depth of door frame or wall unless otherwise indicated.
   c. Length: Full width of opening unless otherwise indicated.
8. Window Stools:
   a. Thickness: ¾”.
   b. Finish: Honed.

2.4 MORTAR MATERIALS

A. Portland Cement: ASTM C 150, Type I or II. Provide natural color or white cement as required to produce mortar color indicated.
1. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or III, and hydrated lime complying with ASTM C 207, Type S.

D. Aggregate: ASTM C 144; except for joints narrower than 1/4 inch and pointing mortar, use aggregate graded with 100 percent passing No. 16 sieve.
1. White Aggregates: Natural white sand or ground white stone.
2. Colored Aggregates: Natural-colored sand or ground marble, granite, or other durable stone; of color necessary to produce required mortar color.
E. Mortar Pigments: Natural and synthetic iron oxides, compounded for use in mortar mixes. Use pigments with a record of satisfactory performance in mortar and containing no carbon black.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      b. Davis Colors; True Tone Mortar Colors.
      c. Solomon Colors; SGS Mortar Colors.

F. Latex Additive: Manufacturer's standard non-staining water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement mortar bed, and not containing a retarder.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. Bonsal.
      c. Bostik Findley Inc.
      d. C-Cure.
      e. Custom Building Products.
      f. DAP Inc.
      g. Laticrete International, Inc.
      h. MAPEI Corp.
      i. Summitville Tiles, Inc.
      j. TEC Specialty Construction Brands; H. B. Fuller Company.

G. Thin-Set Mortar:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. Bonsal.
      c. Bostik Findley Inc.
      d. C-Cure.
      e. Custom Building Products.
      f. DAP Inc.
      g. Laticrete International, Inc.
      h. MAPEI Corp.
      i. Summitville Tiles, Inc.
      j. TEC Specialty Construction Brands; H. B. Fuller Company.
   2. Latex-Portland Cement Mortar: ANSI A118.4, consisting of the following:
      a. Prepackaged Dry-Mortar Mix: Factory-prepared mixture of portland cement; dry, redispersible, ethylene vinyl acetate additive; and other ingredients to which only water needs to be added at Project site.
      b. Mixture of Dry-Mortar Mix and Latex Additive: Mixture of prepackaged dry-mortar mix and styrene-butadiene-rubber or acrylic-resin liquid-latex additive.

H. Water: Clean, non-alkaline and potable.

2.5 GROUT

A. Grout Colors: Match Architect's samples.

B. Polymer Modified Cement Grout: ANSI A118.7.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. Bonsal.
      c. Bostik Findley Inc.
      d. C-Cure.
e. Custom Building Products.
f. DAP Inc.
g. Laticrete International, Inc.
h. MAPEI Corp.
i. Summitville Tiles, Inc.
j. TEC Specialty Construction Brands; H. B. Fuller Company.

2. Polymer Type: Either ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients, or acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.

3. Unsanded grout mix for joints 1/8 inch and narrower.

4. Sanded grout mix for joints wider than 1/8 inch.

2.6 ACCESSORIES

A. Temporary Spacers: Resilient plastic, nonstaining to stone, sized to suit joint thickness.

B. Waterproofing and Crack Suppression Membrane: Corrugated polyethelene with dovetail shaped corrugations for adhering to Portland cement mortar and with anchoring webbing on the underside; 39" wide x 3/16" nom thickness.


C. Reinforcing Wire: Galvanized, welded, 0.062-inch- diameter wire; 2-by-2-inch mesh; comply with ASTM A 185 and ASTM A 82 except for minimum wire size.

D. Control-Joint Filler: Neoprene.

E. Cleaner: Stone cleaner specifically formulated for stone types, finishes, and applications indicated, as recommended by stone producer and, if a sealer is specified, by sealer manufacturer. Do not use cleaning compounds containing acids, caustics, harsh fillers, or abrasives.

F. Floor Sealer for Slate: Colorless, slip- and stain-resistant sealer that does not affect color or physical properties of stone surfaces, as recommended by stone producer for application indicated. Sealer to be non-changing in color over time, and provide a matte finish.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Bostik Findley Inc.
   b. Custom Building Products.
   c. Hillyard, Inc.
   d. HMK Stone Care System.
   e. Miracle Sealants Company.
   f. Stonecare International.
   g. Summitville Tiles, Inc.

2.7 MORTAR AND GROUT MIXES

A. Mortar: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortar of uniform quality and with optimum performance characteristics.

1. Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated. Do not use calcium chloride.

2. Combine mortar materials and thoroughly mix in a mechanical batch mixer unless otherwise indicated. Discard mortar when it has reached initial set.

3. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding any water. Add only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches desired
consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.

B. Portland Cement-Lime Setting Mortar: ASTM C 270, Proportion Specification, Type N. Use amount of water to produce a stiff mixture with a moist surface when bed is ready to receive stone.

C. Latex-Modified Portland Cement Setting Mortar: Proportion and mix portland cement, aggregate, and latex additive to comply with latex-additive manufacturer's written instructions and to produce a stiff mixture with a moist surface when bed is ready to receive stone.

D. Mortar-Bed Bond Coat: Mix neat cement and latex additive to a creamy consistency.

E. Latex-Modified Portland Cement Bond Coat: Proportion and mix portland cement, aggregate, and latex additive to comply with latex-additive manufacturer's written instructions.

F. Pointing Mortar: Comply with requirements indicated above for setting mortar, including type and the following:
1. Pigmented Pointing Mortar: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1:10, by weight.

G. Joint Grout: Comply with mixing requirements in referenced ANSI standards and with manufacturer's written instructions.

2.8 STONE FABRICATION

A. Select stone for intended use to prevent fabricated units from containing cracks, seams, and starts that could impair structural integrity or function.
1. Repairs that are characteristic of the varieties specified are acceptable provided they do not impair structural integrity or function and are not aesthetically unpleasing, as judged by Architect.

B. Fabricate stone to comply with requirements indicated and with the following references:
1. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
2. For stone not otherwise indicated, comply with recommendations in MIA's "Dimension Stone - Design Manual."

C. Cut stone to produce pieces of thickness, size, and shape indicated, including details on Drawings and Shop Drawings.
1. Pattern: As indicated.
2. Stone Edges: Square cut with top corner slightly eased to prevent snipping.

D. Pattern Arrangement: Fabricate and arrange stone units with veining and other natural markings to comply with the following requirements:
1. Cut stone from one block or contiguous, matched blocks in which natural markings occur.
2. Arrange units with veining with all pieces aligned in the same direction, as directed by Architect.
3. Arrange units in side-slip and end-slip pattern.

E. Fabricate stone thresholds in sizes and profiles as indicated or required to provide transition between adjacent floor finishes.
1. Bevel edges of thresholds at 1:2 slope, aligning lower edge of bevel with adjacent floor finish. Limit height of bevel to 1/2 inch or less, and finish bevel to match face of threshold.

F. Fabricate stone stair treads in sizes and profiles indicated.

G. Carefully inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units. Clean sawed backs of stones to remove rust stains and iron particles.
   1. Grade and select stone for overall uniform appearance when assembled in place.
   2. Natural variations in appearance are acceptable if installed stone units match range of colors and other appearance characteristics represented in approved Samples and mockups.

H. Stair treads and other stone where bottom is semi-exposed or exposed to view: Finish underside of stone stair treads and other stone material where underside is subjected to view.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive stone, with Installer present, for compliance with requirements and other conditions affecting performance.

B. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of stone flooring.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Vacuum clean concrete substrates to remove dirt, dust, debris, and loose particles.

B. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

C. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 INSTALLATION, GENERAL

A. Do necessary field cutting as stone is set. Cut lines straight and true and finish field-cut edges to match shop-cut edges.
   1. Use power saws with diamond blades to cut stone.

B. Set stone to comply with Drawings and Shop Drawings. Match stone for color and pattern by using units numbered in sequence as indicated on Shop Drawings.

C. Scribe and field-cut stone as necessary to fit at obstructions. Produce neat joints of size specified or indicated.

D. Expansion- and Control-Joint Installation: Locate and install according to Drawings and Shop Drawings.
3.4 INSTALLATION TOLERANCES

A. Variation in Line: For positions shown in plan for edges of paving, flooring, ramps, steps, changes in color or finish, and continuous joint lines, do not exceed 1/8 inch in 96 inches, 1/4 inch in 20 feet, or 3/8 inch maximum.

B. Variation in Joint Width: Do not vary joint thickness more than 1/16 inch or 1/4 of nominal joint width, whichever is less.

C. Variation in Surface Plane: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 3/8 inch maximum from level or slope indicated.

D. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/32-inch difference between planes of adjacent units.

3.5 INSTALLATION OF STONE OVER CLEAVAGE MEMBRANE

A. Place cleavage membrane over substrates indicated to receive stone, lapped at least 4 inches at joints.

B. Place mortar bed over cleavage membrane with reinforcing wire fabric fully embedded in middle of mortar bed. Spread, tamp, and screed to uniform thickness at elevations required for setting stone to finished elevations indicated.

C. Mix and place only that amount of mortar bed that can be covered with stone before initial set. Cut back, bevel edge, and discard material that has reached initial set before stone can be placed.

D. Place stone before initial set of mortar occurs. Immediately before placing stone on setting bed, apply uniform 1/16-inch-thick bond coat to bed or to back of each stone unit.

E. Tamp and beat stone with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each unit in a single operation before initial set of mortar; do not return to areas already set and disturb stone for purposes of realigning finished surfaces or adjusting joints.

F. Rake out joints to depth required to receive grout as units are set.

3.6 STONE THRESHOLD INSTALLATION

A. At locations adjacent to stone flooring, install stone thresholds in same type of setting bed as abutting stone flooring unless otherwise indicated.

1. Set thresholds in thin-set, latex-portland cement mortar to comply with ANSI A108.5 at locations where mortar bed would otherwise be exposed above other adjacent paving and flooring.

B. At locations not adjacent to stone flooring, install stone thresholds in thin-set, latex-portland cement mortar to comply with ANSI A108.5.

3.7 STONE STAIR TREAD INSTALLATION

A. Place reinforcing wire fabric tack welded to steel stair pan, according to drawing details, in a manner which will provide keying. Lap at least one full mesh at joints. Support mesh so that it becomes embedded in the middle of the setting bed. Hold edges back from vertical surfaces about 1/2 inch, unless indicated otherwise.
B. Place mortar bed over steel stair pan with reinforcing wire fabric fully embedded in the middle of the mortar bed. Spread, tamp and screed to uniform thickness at elevations required for setting stone to finished elevations indicated.

C. Mix and place only that amount of mortar bed that can be covered with stone before initial set. Cut back, bevel edge, and discard material that has reached initial set before stone can be placed.

D. Place stone before initial set of mortar occurs. Immediately before placing stone on setting bed, apply uniform 1/16-inch-thick bond coat to bed or to back of each stone unit.

E. Tamp and beat stone with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each unit in a single operation before initial set of mortar; do not return to areas already set and disturb stone for purposes of realigning finished surfaces or adjusting joints.

F. Rake out joints to depth required to receive pointing mortar as units are set.

G. Point joints after setting. Fill full with mortar type and color indicated. Tool joints flat, uniform, and smooth, without visible voids.

3.8 GROUTING

A. Grout stone joints with polymer-modified cement grout to comply with ANSI A108.10 and with manufacturer’s written instructions.
   1. Do not use sanded grout for polished stone.
   2. Grout joints as soon as possible after initial set of setting bed. Force grout into joints, taking care not to smear grout on adjoining stone and other surfaces. After initial set of grout, finish joints by tooling to produce a slightly concave polished joint, free of drying cracks.
   3. Cure grout by maintaining in a damp condition for seven days except as otherwise recommended by manufacturer.

B. Grout stone joints with water-cleanable epoxy grout to comply with ANSI A108.6 and with manufacturer’s written instructions.

3.9 ADJUSTING AND CLEANING

A. Remove and replace stonework of the following description:
   1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Architect.
   2. Defective joints.
   3. Stone paving, flooring, and joints not matching approved Samples and mockups.
   4. Stonework not complying with other requirements indicated.

B. Replace in a manner that results in stonework matching approved Samples and mockups, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean stonework as work progresses. Remove mortar fins and smears before tooling joints.

D. Clean stonework after setting and grouting are complete. Use procedures recommended by stone fabricator for types of application.

E. Apply sealer to cleaned stonework according to sealer manufacturer’s written instructions.

3.10 PROTECTION

A. Prohibit traffic from installed stone for a minimum of 72 hours.
B. Protect installed stonework during construction with nonstaining kraft paper. Where adjoining areas require construction work access, cover stonework with a minimum of 3/4-inch untreated plywood over nonstaining kraft paper.

3.11 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 09 63 40
SECTION 09 65 13 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Resilient base.
   2. Resilient stair accessories.
   3. Resilient molding accessories.

B. Related Sections:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 09 Section "Linoleum Flooring" for linoleum floor coverings.
   3. Division 09 Section "Resilient Tile Flooring" for resilient floor tile.
   4. Division 09 Section "Carpet Tile" for carpet tile flooring.

C. LEED Opportunities: This Section has opportunities for the following LEED points:
   1. Materials and Resources Prerequisite 1 and Credits 2.1, 4.1, 4.2 and 5.1.
   2. Indoor Environmental Quality Credit 4.1.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:
   1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
   2. Credit MR 5.1 and 5.2: Manufacturers certificate demonstrating that each material or product indicated was extracted, harvested or recovered, as well as manufactured within 500 miles of the project site.
   3. Product Data for Credit IEQ 4.1: For adhesives, sealants and chemical-bonding compounds, documentation including printed statement of VOC content and chemical components."Laboratory Test Reports for Credit IEQ 4" Subparagraph below applies to LEED for Schools.

C. Samples for Initial Selection: For each type of product indicated.

D. Samples for Verification: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches long, of each resilient product color, texture, and pattern required.
E. Product Schedule: For resilient products. Use same designations indicated on Drawings.

1.4 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 QUALITY ASSURANCE
A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
   1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
B. Mockups: Provide resilient products with mockups specified in other Sections.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

1.7 PROJECT CONDITIONS
A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (3deg C), in spaces to receive resilient products during the following time periods:
   1. 48 hours before installation.
   2. During installation.
   3. 48 hours after installation.
B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
C. Install resilient products after other finishing operations, including painting, have been completed.

1.8 WARRANTY
A. Stair Tread and Stair Accessories Warranty: Written warranty, signed by manufacturer agreeing to repair or replace rubber stair tread and accessories that fails in materials or workmanship. Failures include, but are not limited to, excessive wear, buckling, cupping, warping, splitting, cracking and delamination.
   1. Contractor shall install rubber stair treads with manufacturer’s recommended adhesives and installation techniques as is required for a five year warranty.
B. Rubber Base Warranty: Written warranty, signed by manufacturer agreeing to repair or replace rubber base that fails in materials or workmanship. Failures include, but are not limited to, excessive wear, buckling, cupping, warping, splitting, cracking and delamination.

1. Contractor shall install rubber base with manufacturer’s recommended adhesives and installation techniques as is required for a three year warranty.

PART 2 - PRODUCTS

2.1 RESILIENT BASE

A. Resilient Base:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Allstate Rubber Corp.; Stoler Industries.
   b. Armstrong World Industries, Inc.
   c. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
   d. Endura Rubber Flooring; Division of Burke Industries, Inc.
   e. Estrie Products International; American Biltrite (Canada) Ltd.
   f. Flexco, Inc.
   g. Johnsonite.
   h. Mondo Rubber International, Inc.
   i. Musson, R. C. Rubber Co.
   j. Nora Rubber Flooring; Freudenberg Building Systems, Inc.
   k. PRF USA, Inc.
   l. Roppe Corporation, USA.
   m. VPI, LLC; Floor Products Division.


1. Material Requirement: Type TP (rubber, thermoplastic).

C. Minimum Thickness: 0.125 inch.

D. Height: 2-1/2 inches, unless otherwise indicated on Drawings.

E. Lengths: Coils in manufacturer’s standard length.

F. Outside Corners: Preformed.

G. Inside Corners: Job formed or preformed.

H. Finish: As selected by Architect from manufacturer’s full range.

I. Colors and Patterns: As selected by Architect from full range of standard and premium industry colors.

2.2 RESILIENT STAIR ACCESSORIES

A. Resilient Stair Treads:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
   b. Endura Rubber Flooring; Division of Burke Industries, Inc.
   c. Estrie Products International; American Biltrite (Canada) Ltd.
   d. Flexco, Inc.
   e. Johnsonite.
   f. Mondo Rubber International, Inc.
   g. Musson, R. C. Rubber Co.
   h. Nora Rubber Flooring; Freudenberg Building Systems, Inc.
   i. PRF USA, Inc.
   j. R.C.A. Rubber Company (The).
   k. Roppe Corporation, USA.
   l. VPI, LLC; Floor Products Division.

B. Resilient Stair Treads Standard: ASTM F 2169.
   1. Material Requirement: Type TS (rubber, vulcanized thermoset).
   2. Surface Design:
      a. Class 2, Pattern: Raised-disc design.
   1. Manufacturing Method: If required by Code or the authorities having jurisdiction, use Group 1, tread with embedded abrasive strips and/or Group 2, tread with contrasting color for the visually impaired.

C. Nosing Style: Square, adjustable to cover angles between 60 and 90 degrees.

D. Nosing Height: 1-1/2 inches, unless otherwise indicated.

E. Thickness: 1/4 inch and tapered to back edge.

F. Size: Lengths and depths to fit each stair tread in one piece.

G. Risers: Smooth, flat, toeless, height and length to cover risers; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.
   1. Thickness: 0.125 inch.

H. Stringers: Of same thickness as risers, height and length after cutting to fit risers and treads and to cover stair stringers; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.

I. Colors and Patterns: As selected by Architect from full range of standard and premium industry colors.

2.3 RUBBER FLOOR TILE, GENERAL


2.4 RUBBER FLOOR TILE – STAIR LANDINGS

   A. Basis of Design Product: Subject to compliance with requirements, provide "Raised Disc Finish Rubber Tile," as manufactured by Roppe Corporation, or comparable product.
B. Tile Standard: ASTM F 1344, Class I-B, homogeneous rubber tile, through mottled.

C. Hardness: Min 85 Shore A, per ASTM F1344 and ASTM D-2240.

D. Wearing Surface: Smooth Molded pattern.
   1. Molded-Pattern Figure: Raised Disc.

E. Thickness: 1/8 inch (3.175 mm)

F. Size: 12 x 12 inches.

G. Edge Style: Square Edge.

H. Seaming Method: N/A

I. Attachment: Adhered.

J. Colors and Patterns: As selected by Architect to match stair riser and treads.

2.5 RESILIENT STAIR ACCESSORIES AT LECTURE HALL (022)

A. See Section 09 68 13 Tile Carpeting, Division 2.2 C

2.6 RESILIENT MOLDING ACCESSORY

A. Resilient Molding Accessory:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
      b. Flexco, Inc.
      c. Johnsonite.
      d. R.C.A. Rubber Company (The).
      e. Roppe Corporation, USA.
      f. VPI, LLC; Floor Products Division.

B. Description: Carpet edge for glue-down applications, Nosing for carpet, Nosing for resilient floor covering, Reducer strip for resilient floor covering, Joiner for tile and carpet, Transition strips and other profiles as indicated.

C. Material: Vulcanized, Thermoset Rubber.

D. Profile and Dimensions: As indicated in drawings or as required for each transition between different flooring materials and conditions.

E. Colors and Patterns: As selected by Architect from full range of standard and premium industry colors.
2.7 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.
   1. Adhesives shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), except that adhesive for rubber stair treads shall have a VOC content of 60 g/L or less.

C. Stair-Tread-Nose Filler: Two-part epoxy compound recommended by resilient tread manufacturer to fill nosing substrates that do not conform to tread contours.

D. Floor Polish: Provide protective liquid floor polish products as recommended by resilient stair tread manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to manufacturer’s written instructions to ensure adhesion of resilient products.

B. Concrete Substrates for Resilient Stair Treads and Accessories: Prepare according to ASTM F 710.
   1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.
   4. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
      a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
      b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.
C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient products until they are same temperature as the space where they are to be installed.

1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

### 3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

H. Job-Formed Corners:

1. Inside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends.

### 3.4 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Stair Accessories:

1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
2. Tightly adhere to substrates throughout length of each piece.
3. For treads installed as separate, equal-length units, install to produce a flush joint between units.

C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of carpet or resilient floor covering that would otherwise be exposed.
3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.

B. Perform the following operations immediately after completing resilient product installation:
   1. Remove adhesive and other blemishes from exposed surfaces.
   2. Sweep and vacuum surfaces thoroughly.
   3. Damp-mop surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, visible adhesive and surface blemishes from resilient stair treads and horizontal surfaces before applying liquid floor polish. Use commercially available product acceptable to manufacturer.
   1. Coordinate selection of floor polish with Owner's maintenance service.
   2. Apply number of coats recommended by manufacturer.

E. Cover resilient products with undyed untreated kraft paper until Substantial Completion.

F. Do not move heavy and sharp objects directly over surfaces. Place hardboard or plywood panels over flooring and under objects while they are being moved. Slide or roll objects over panels without moving panels.

3.6 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 09 65 13
SECTION 09 65 16.13 - LINOUEM FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Linoleum floor tile.
   2. Linoleum sheet flooring.

B. Related Sections:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 09 Section "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with linoleum floor covering.

C. LEED Opportunities: This Section has opportunities for the following LEED points:
   1. Materials and Resources Prerequisite 1 and Credits 2.1, 4.1, 4.2 and 5.1.
   2. Indoor Environmental Quality Credit 4.1.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC contents.
   2. Refer to Division 1 Section “LEED Requirements” for additional submittal requirements.
   3. Credits MR 4.1 and MR 4.2: Product Data indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
      a. Include statement indicating costs for each product having recycled content.
   4. Product Data for Credit MR 6.0: For linoleum flooring, including printed statement of costs for each rapidly renewable material.
   5. Refer to Division 1 Section “Sustainable Design Requirements” for additional submittal requirements.

C. Shop Drawings: For each type of floor covering. Include floor covering layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
   1. Show details of special patterns.

D. Samples for Initial Selection: For each type of floor covering indicated.
   1. Include similar Samples of installation accessories involving color selection.

E. Samples for Verification: In manufacturer's standard size, but not less than four (4) full size tiles of each color and pattern of floor covering required.
F. Heat-Welded Seam Samples: For each floor covering product and welding bead color and pattern combination required; with seam running lengthwise and in center of 6-by-9-inch Sample applied to rigid backing and prepared by Installer for this Project.

G. Product Schedule: For floor covering.

H. Warranty: Submit Manufacturer’s warranty as specified in this section.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of floor covering to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Floor Tile: Furnish 1 box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.
   2. Sheet Flooring: Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, in roll form and in full roll width for each color, pattern, and type of sheet flooring installed.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor covering installation.
   1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required.

B. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
   1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store floor coverings and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 65 deg F (18 deg C) or more than 90 deg F (32 deg C).
   1. Floor Tile: Store on flat surfaces.

1.9 PROJECT CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive floor coverings during the following time periods:
   1. 72 hours before installation.
   2. During installation.
3.  72 hours after installation.

B.  Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).

C.  Close spaces to traffic during floor covering installation.

D.  Close spaces to traffic for 72 hours after floor covering installation.

E.  Install floor coverings after other finishing operations, including painting, have been completed.

1.10 WARRANTY

A.  Provide Manufacturer’s standard five year warranty commencing on date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A.  Basis-of-Design Product: Subject to compliance with requirements, provide product listed below or comparable product meeting the requirements of this section:
   1.  “Walton Uni” Linoleum sheet product as manufactured by Forbo Flooring, Inc.
   2.  “Marmoleum Dual” Linoleum tiles as manufactured by Forbo Flooring, Inc.

2.2 LINOLEUM FLOOR COVERING

A.  Floor Tile: ASTM F 2195, Type I, linoleum floor tile with fibrous backing.
   1.  Nominal Floor Tile Size: 20 by 20 inches.

B.  Sheet Flooring: ASTM F 2034, Type I, linoleum sheet with backing.
   1.  Roll Size: In manufacturer’s standard length by not less than 78 inches wide.


D.  Thickness: 0.10 inch.

E.  Finish coat: Provide manufacturer’s proprietary top coat finish,

F.  Slip Resistance: 0.6 per ASTM D2047.

G.  Castor Resistance: EN 425: Suitable for office chairs with castors.

H.  Colors and Patterns: As selected by Architect from full range of standard and premium industry colors and patterns.

2.3 INSTALLATION MATERIALS

A.  Trowelable Leveling and Patching Compounds: Latex-modified, Portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
B. Adhesives: Water-resistant type recommended by manufacturer to suit products and substrate conditions indicated.
   1. Adhesives shall have a VOC content of not more than 50 g/L when calculated according to 40 CFR 59, Subpart DEPA Method 24).

   1. As selected by Architect from manufacturer's full range to match linoleum floor covering.

D. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor coverings.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of floor coverings.

B. Concrete Substrates: Prepare according to ASTM F 710.
   1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   2. Remove substrate coatings and other substances that are incompatible with floor covering adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
   4. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
      a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
      b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.
      c. Proceed with installation only after verifying that floor substrate and environmental conditions meet manufacturer's requirements.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install floor coverings until they are same temperature as space where they are to be installed.
   1. Move floor coverings and installation materials into spaces where they will be installed at least 72 hours in advance of installation.
E. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

3.3 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions for installing floor coverings.

B. Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings.

C. Extend floor coverings into toe spaces, door reveals, closets, and similar openings.

D. Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on subfloor. Use chalk or other nonpermanent marking device.

E. Install floor coverings on covers for telephone and electrical ducts and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of floor covering installed on covers and adjoining floor covering. Tightly adhere floor covering edges to substrates that abut covers and to cover perimeters.

F. Adhere floor coverings to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

G. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and use welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.

3.4 LINOLEUM FLOOR TILE INSTALLATION

A. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so floor tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

1. Lay floor tiles square with room axis in running bond pattern in orientation indicated or otherwise directed by Architect.

B. Match floor tiles for color and pattern by selecting tiles from cartons in same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed floor tiles.

1. Lay floor tiles with grain running in one direction.

3.5 LINOLEUM SHEET FLOORING INSTALLATION

A. Unroll sheet floorings and allow them to stabilize before cutting and fitting.

B. Lay out sheet floorings as follows:

1. Maintain uniformity of floor covering direction.

2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in floor covering substrates.

3. Match edges of floor coverings for color shading at seams.

4. Avoid cross seams.

5. Eliminate deformations that result from hanging method used during drying process (stove bar marks).
3.6 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of floor coverings.

B. Perform the following operations immediately after completing floor covering installation:
   1. Remove adhesive and other blemishes from exposed surfaces.
   2. Sweep and vacuum surfaces thoroughly.
   3. Damp-mop surfaces to remove marks and soil.

C. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, visible adhesive and surface blemishes from floor coverings before applying liquid floor polish.
   1. Apply number of coats as recommended by manufacturer for initial floor finishing.

E. After allowing drying room film (yellow film caused by linseed oil oxidation) to disappear, cover floor coverings until Substantial Completion.

F. Do not move heavy and sharp objects directly over floor covering surfaces. Place plywood or hardboard panels over floor coverings and other objects while they are being moved. Slide or roll objects over panels without moving panels.

G. Replace all damaged or loose linoleum tile prior to final completion.

3.7 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 09 65 16.13
SECTION 09 66 10 - EPOXY TERRAZZO FLOORING W/RECYCLED GLASS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Thin-set, epoxy-resin terrazzo flooring.

B. Related Requirements:

1. Division 07 Section "Joint Sealants" for sealants installed with terrazzo.

1.3 DEFINITIONS

A. Aggregate: Recycled glass (80%).

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to terrazzo including, but not limited to, the following:

a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.

b. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

c. Review special terrazzo designs and patterns.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

2. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.
3. Product Data for Credit IEQ 4.3: For sealers, documentation including printed statement of VOC content.
4. Product Data for Credit IEQ 4.3: For terrazzo flooring, documentation from an independent testing agency indicating compliance with the FloorScore Standard.

C. Shop Drawings: Include terrazzo installation requirements. Include plans, elevations, sections, component details, and attachments to other work. Show layout of the following:
   1. Divider strips.
   2. Accessory strips.

D. Samples for Initial Selection: NTMA color plates showing the full range of colors and patterns available for each terrazzo type.

E. Samples for Verification: For each type, material, color, and pattern of terrazzo and accessory required showing the full range of color, texture, and pattern variations expected. Label each terrazzo sample to identify manufacturer’s matrix color and aggregate types, sizes, and proportions. Prepare Samples of same thickness and from same material to be used for the Work, in size indicated below:
   1. Terrazzo: Three (3) samples, minimum 6-inch- square for each finished combination of Epoxy Resin Color and Glass Aggregate Color for acceptance before proceeding with the Work.
   2. Accessories: 6-inch- long Samples of each exposed strip item required.

1.6 INFORMATIONAL SUBMITTALS
A. Qualification Data: For Installer.
B. Material Certificates: For each type of terrazzo material or product, from manufacturer.
C. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.

1.7 CLOSEOUT SUBMITTALS
A. Maintenance Data: For terrazzo to include in maintenance manuals.

1.8 QUALITY ASSURANCE
A. Fabricator Qualifications: Company specializing in fabricating work specified in this Section with minimum five years experience in type work required for Project.
B. Installer Qualifications:
   1. Engage an installer who is a contractor member of NTMA.
   2. Engage an installer who is certified in writing by terrazzo manufacturer as qualified to install manufacturer’s products.
C. Source Limitations: Obtain primary terrazzo materials from single source from single manufacturer. Provide secondary materials including patching and fill material, joint sealant,
and repair materials of type and from source recommended by manufacturer of primary materials.

D. Source Limitations for Aggregates: Obtain each color, grade, type, and variety of granular materials from single source with resources to provide materials of consistent quality in appearance and physical properties.

E. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups for terrazzo including accessories.
   a. of typical poured-in-place flooring condition for each color and pattern in locations directed by Architect.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in supplier's original wrappings and containers, labeled with source's or manufacturer's name, material or product brand name, and lot number if any.

B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting terrazzo installation.

B. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.

C. Close spaces to traffic during terrazzo application and for not less than 24 hours after application unless manufacturer recommends a longer period.

D. Control and collect water and dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NTMA Standards: Comply with NTMA's "Terrazzo Specifications and Design Guide" and with written recommendations for terrazzo type indicated unless more stringent requirements are specified.
2.2 ACCEPTABLE FABRICATORS

A. Basis of Design: Subject to compliance with requirements indicated provide products from fabricators listed below, or established equal:
   1. EnviroGLAS®, 5048 Tennyson Parkway, Suite 202, 972.473.3725, 888.523.7894 toll free voice.

2.3 MATERIAL

A. EnvioTRAZ Epoxy Terrazzo with Glass and/or Porcelain Aggregate: Provide sound, hard, durable, epoxy terrazzo of uniform strength, color, and texture, free of flaws, cracks, seams, or other mineral or organic defects which affect visual appearance or structural integrity.
   1. EnviroPOxy Resin Performance Criteria without EnviroSCAPE added:

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness</td>
<td>ASTM D-2240 using Shore D Durometer</td>
<td>60-85</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>ASTM D-638 run @ 0.2&quot; minimum</td>
<td>3,000 psi minimum</td>
</tr>
<tr>
<td>Compressive Strength</td>
<td>ASTM D-695 Specimen B Cylinder</td>
<td>10,000 psi minimum</td>
</tr>
<tr>
<td>Chemical Resistance</td>
<td>ASTM D-1308/ 7 days at room temperature by immersion method have no deleterious effects, following contaminants used: Distilled water</td>
<td>No effect</td>
</tr>
<tr>
<td></td>
<td>Mineral water</td>
<td></td>
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<tr>
<td></td>
<td>Isopropanol</td>
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<tr>
<td></td>
<td>Ethanol</td>
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<td></td>
<td>Detergent Solution .025</td>
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<tr>
<td></td>
<td>1% Soap Solution</td>
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<td></td>
<td>10% Sodium Hydroxide</td>
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<tr>
<td></td>
<td>10% Hydrochloric Acid</td>
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</tr>
<tr>
<td></td>
<td>30% Sulfuric Acid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5% Acetic Acid</td>
<td></td>
</tr>
</tbody>
</table>

2. EnviroPOXY Resin color: As selected by Architect from Manufacturer’s full available range of standard and premium colors.

B. Aggregate:
   1. 100% Pre and/or Post Recycled Glass and/or Porcelain Aggregate.
   2. EnviroSCAPE Aggregate: As supplied by EnviroGLAS® LLC ‘ONLY’
   3. Sizes to conform to NTMA Gradation standards. Aggregate color as selected by Architect from Manufacturer’s full available range of standard and premium colors.

C. EnviroTRAZ Epoxy Terrazzo Flooring with Glass Matrix: Provide sound, hard, durable, epoxy terrazzo of uniform strength, color, and texture, free of flaws, cracks, seams, or other mineral or organic defects which affect visual appearance or structural integrity.
   1. EnviroPOXY Resin blended with three volumes of EnviroSCAPE glass finished to nominal 1/4" thickness, per Manufacturer’s recommendations:
   2. Performance criteria with EnviroSCAPE aggregate:
<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammability</td>
<td>ASTM D-635</td>
<td>Self-extinguishing, extent of burning 0.25 maximum</td>
</tr>
<tr>
<td>Thermal Coefficient of Linear</td>
<td>ASTM D-696</td>
<td>25 x 10-6&quot; per 140 degrees Fahrenheit. Temperature range: 12 degrees – 140</td>
</tr>
<tr>
<td>Expansion</td>
<td></td>
<td>degrees</td>
</tr>
<tr>
<td>Bond Strength</td>
<td>Surface Soundness Adhesion Test</td>
<td>100% Concrete failure minimum 300 PSI minimum tensile strength</td>
</tr>
</tbody>
</table>

3. Acceptable **Product**: EnviroTRAZ™.

4. Proportions:
   a. EnviroPOXY Terrazzo Topping: Recommended (80) 50 lb bags per 1000 feet of coverage.

5. Mixing:
   a. EnviroPOXY Terrazzo Topping: Blend and Mix EnviroSCAPE glass aggregate, Filler, and EnviroPOXY Resin per Manufacturer's recommendations.

D. Strips:
   1. Stop and Divider Strips: L type, zinc, depth as required.

E. Terrazzo Cleaner:
   1. Ph factor between 7 and 10, where applicable.
   2. Biodegradable and phosphate-free.

F. Sealer:
   1. Ph factor between 7 and 10, where applicable.
   2. Shall not discolor or amber
   3. Flash Point: ASTM D-56 – 80 degrees Fahrenheit minimum, where applicable.
   4. UL-listed as “Slip Resistant”.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions, including levelness tolerances, have been corrected.

3.2 PREPARATION

A. Clean substrates of substances, including oil, grease, and curing compounds, that might impair terrazzo bond. Provide clean, dry, and neutral substrate for terrazzo application.

B. Concrete Slabs:
1. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with terrazzo.
   a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
   b. Repair damaged and deteriorated concrete according to terrazzo manufacturer's written recommendations.
   c. Use patching and fill material to fill holes and depressions in substrates according to terrazzo manufacturer's written instructions.

C. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
   1. Moisture Testing: Perform tests indicated below.
      a. Calcium Chloride Test: Perform anhydrous calcium chloride test per ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
         1) Perform tests so that each test area does not exceed 200 sq. ft., and perform not less than two tests in each installation area and with test areas evenly spaced in installation areas.
      b. In-Situ Probe Test: Perform relative-humidity test using in-situ probes per ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative-humidity-level measurement.
      c. Test Method: Test for moisture content by method recommended in writing by terrazzo manufacturer. Proceed with installation only after substrates pass testing.

D. Protect other work from water and dust generated by grinding operations. Control water and dust to comply with environmental protection regulations.
   1. Erect and maintain temporary enclosures and other suitable methods to limit water damage and dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

3.3 EPOXY TERRAZZO INSTALLATION

A. Comply with NTMA's written recommendations for terrazzo and accessory installation.

B. Place, rough grind, grout, cure grout, fine grind, and finish terrazzo according to manufacturer's written instructions and NTMA's "Terrazzo Specifications and Design Guide."

C. Installation Tolerance: Limit variation in terrazzo surface from level to 1/4 inch in 10 feet; noncumulative.

D. Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control-joint strips.

E. Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted.
F. Flexible Reinforcing Membrane:
   1. Prepare and prefill substrate cracks with membrane material.
   2. Install membrane to produce full substrate coverage in areas to receive terrazzo.
   3. Reinforce membrane with fiberglass scrim.
   4. Prepare membrane according to manufacturer’s written instructions before applying substrate primer.

G. Primer: Apply to terrazzo substrates according to manufacturer’s written instructions.

H. Strip Materials:
   1. Divider Strips:
      a. Locate divider strips in locations indicated.
      b. Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.
   2. Accessory Strips: Install as required to provide a complete installation.

I. Placing Terrazzo
   1. Prime sub-floor in accordance with Manufacturer’s recommendations.
   2. Place terrazzo mixture in panels formed by divider strips. Trowel mixture to top of strips.
   3. Allow to cure 24 hours prior to grinding.

J. Finishing: finish terrazzo to NTMA requirements.
   1. Rough Grinding: Grind with 24 or finer grit stones or with comparable diamond plates.
      a. Follow initial grind with 80 – 120 grit stones.
   2. Grouting: Cleanse with clean water and rinse thoroughly.
      a. Remove excess rinse water and allow drying.
      b. Machine or hands apply grout to fill voids completely.
      c. Allow grout to cure.
   3. Fine Grinding: Grind with 220 or finer grit stones to achieve superior finish.

3.4 REPAIR
A. Cut out and replace terrazzo areas that evidence lack of bond with substrate. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA’s written recommendations, as approved by Architect.

3.5 CLEANING AND PROTECTION
A. Cleaning:
   1. Remove grinding dust from installation and adjacent areas.
   2. Wash surfaces with cleaner according to NTMA’s written recommendations and manufacturer’s written instructions; rinse surfaces with water and allow them to dry thoroughly.

B. Sealing:
   1. Seal surfaces according to NTMA’s written recommendations.
2. Apply sealer according to sealer manufacturer's written instructions.

C. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Substantial Completion.

3.6 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:

   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:

   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 09 66 10
SECTION 09 68 13 - TILE CARPETING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes modular, tufted carpet tile as part of the base bid.

B. Related Requirements:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 09 Section "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.
   3. Division 09 Section "Access Flooring" for access floor below carpet tile.

C. LEED Opportunities: This Section has opportunities for the following LEED points:
   1. Materials and Resources Prerequisite 1 and Credits 2.1, 4.1, 4.2 and 5.1.
   2. Indoor Environmental Quality Credit 4.1 and 4.3.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination".
   1. Review methods and procedures related to carpet tile installation including, but not limited to,
      the following:
      a. Review delivery, storage, and handling procedures.
      b. Review ambient conditions and ventilation procedures.
      c. Review subfloor preparation procedures.
      d. Coordinate with access floor.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
   2. Include installation recommendations for each type of substrate.

B. LEED Submittals:
   1. Product Data for Credit EQ 4.1:
      a. For sealants, including printed statement of VOC content and chemical components.
   2. Product Data for Credit EQ 4.3:
      a. For carpet tile, documentation indicating compliance with testing and product requirements of CRI's "Green Label Plus" program.
      b. For installation adhesive, documentation including printed statement of VOC content.
   3. Refer to Division 1 Section "Sustainable Design Requirements" for additional submittal requirements.
   4. Credits MR 4.1 and MR 4.2: Product Data indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.

C. Shop Drawings: Show the following:
1. Columns, doorways, enclosing walls or partitions, built-in cabinets, floor boxes for electrical and data distribution, and locations where cutouts are required in carpet tiles.
2. Carpet tile installation on stepped platforms of Lecture Hall.
3. Extent of and joints within access flooring below as they relate to joints of carpet tile above.
4. Carpet tile type, color, and dye lot.
5. Locations where dye lot changes occur.
6. Type of subfloor.
7. Type of installation.
8. Pattern of installation.
9. Pattern type, location, and direction.
11. Type, color, and location of edge, transition, and other accessory strips.
12. Transition details to other flooring materials.
13. Nosing details at edge of stair treads and platforms.

D. Samples for selection: For each product, submit samples demonstrating the manufacturer's full range of colors available.

E. Samples for Verification: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
   1. Carpet Tile: A minimum of four full-size samples of each type and color selected by architect.
   2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch-long Samples.

F. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

G. Sustainability: Provide the Statement of the Achievement Level the carpet has attained for Bronze, 28 to 36; Silver, 37 to 51; or Gold, 52 to 70 points, based on specific Sustainable Attribute Performance for all product stages according to ANSI/NSF 140.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.

C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
   1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
   2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd.
1.8 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association or who can demonstrate compliance with its certification program requirements.

B. Fire-Test-Response Ratings: Where indicated, provide carpet tile identical to those of assemblies tested for fire response according to NFPA 253 by a qualified testing agency.

C. Mockups: Before installing carpet tile, build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104.

1.10 FIELD CONDITIONS

A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the construction period.

C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

1.11 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
   1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
   2. Failures include, but are not limited to, more than 10 percent edge raveling, snags, runs, dimensional stability, excess static discharge, loss of tuft bind strength, loss of face fiber, and delamination.
   3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE – Type-1

A. Basis-of-Design Product: Subject to compliance with requirements, provide Bentley Prince Street "Really Late Nite TV"

B. Color: Custom Color

C. Pattern: Bentley Prince Street “Really Late Nite TV”, Style: 4RV240AB0T.

D. Fiber Content: Antron Lumena nylon.
E. Fiber Type:

F. Recycled Content: 28% - 32% post consumer.

G. Dye Method: 100% Solution dye.

H. Pile Characteristic: Tufted Tip-Sheared pile.

I. Pile Height: varies due to texture; High 0.206 inch, Medium 0.158 inch, Low 0.094 inch

J. Density:

K. Pile Thickness: .38 for finished carpet tile.

L. Stitches: 10 per inch.

M. Gauge: 1/12 ends per inch.

N. Surface Pile Weight: 24 oz./sq. yd.

O. Total Thickness: 0.380 inch for finished carpet tile.

P. Primary Backing: Select RC Cushion Tile backing materials; consult manufacturers.

Q. Secondary Backing: NexStep Cushion Tile backing materials; consult manufacturers.

R. Size: 19.69 inches by 19.69 inches.


T. Antimicrobial Treatment: Manufacturer's standard "Intersept" treatment. (AATCC 138 washed)

U. Performance Characteristics: As follows:
   1. Radiant Panel Passes Class 1 (ASTM E-648) Critical Radiant Flux
   2. Dry Breaking Strength: Not less than 100 lbf according to ASTM D 2646.
   3. Tuft Bind: according to ASTM D 1335.
   4. Delamination: according to ASTM D 3936.
   5. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
   6. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
   8. Colorfastness to Crocking
   9. Colorfastness to Light:
   10. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.
   11. Electrostatic Propensity: Less than 3.5 kV according to AATCC 134.

2.2 CARPET TILE – Type-2

A. Basis-of-Design Product: Subject to compliance with requirements, provide InterfaceFLOR “Monochrome”

B. Color: Granite

C. Pattern: InterfaceFLOR “Monochrome”, 13857101837.
   1. Style: 13857
2. Color: 101837

D. Fiber Content: 100 percent nylon 6, 6

E. Fiber Type:

F. Recycled Content: 31% - 34% post industrial; 32% post consumer.

G. Dye Method: 100% Solution dye.

H. Pile Characteristic: Tufted Textured Loop pile.

I. Pile Height: 0.18 inch.

J. Density:

K. Pile Thickness: ___ for finished carpet tile

L. Stitches: 10.3 per inch.

M. Gauge: 1/12 ends per inch.

N. Surface Pile Weight: 24 oz./sq. yd.>

O. Primary Backing/Backcoating: GlasBac RE Tile backing materials; consult manufacturers.

P. Secondary Backing: GlasBac Tile or NexStep backing materials; consult manufacturers.

Q. Size: 19.69 inches by 19.69 inches.


S. Antimicrobial Treatment: (AATCC 138 Washed) (AATCC 174 Parts 2&3) Intersept

T. Performance Characteristics: As follows:
   1. Radiant Panel: (AST< E-648) Class 1
   2. Dry Breaking Strength: Not less than 100 lbf according to ASTM D 2646.
   3. Tuft Bind: according to ASTM D 1335.
   4. Delamination: according to ASTM D 3936.
   5. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
   6. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
   8. Colorfastness to Crocking
   9. Colorfastness to Light:
   10. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.
   11. Electrostatic Propensity: Less than 3.0 kV according to AATCC 134.

2.3 CARPET TILE – Type-3

A. Basis-of-Design Product: Subject to compliance with requirements, provide InterfaceFLOR “Monochrome”

B. Color: Custom
C. Pattern: InterfaceFLOR “Monochrome”, 13857-____ (custom color).
   1. Style: 13857
   2. Color: custom

D. Fiber Content: 100 percent nylon 6, 6

E. Fiber Type:

F. Recycled Content: 31% - 34% post industrial; 32% post consumer.

G. Dye Method: 100% Solution dye.

H. Pile Characteristic: Tufted Textured Loop pile.

I. Pile Height: 0.18 inch.

J. Density:

K. Pile Thickness: .119 for finished carpet tile

L. Stitches: 10.3 per inch.

M. Gauge: 1/12 ends per inch.

N. Surface Pile Weight: 24 oz./sq. yd.>

O. Primary Backing/Backcoating: GlasBac RE Tile backing materials; consult manufacturers.

P. Secondary Backing: GlasBac Tile or NexStep backing materials; consult manufacturers.

Q. Size: 19.69 inches by 19.69 inches.


S. Antimicrobial Treatment: (AATCC 138 Washed) (AATCC 174 Parts 2&3) Intersept

T. Performance Characteristics: As follows:
   1. Radiant Panel: (AST< E-648) Class 1
   2. Dry Breaking Strength: Not less than 100 lbf according to ASTM D 2646.
   3. Tuft Bind: according to ASTM D 1335.
   4. Delamination: according to ASTM D 3936.
   5. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
   6. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
   8. Colorfastness to Crocking
   9. Colorfastness to Light:
   10. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.
   11. Electrostatic Propensity: Less than 3.0 kV according to AATCC 134.
2.4 Emissions: Provide carpet tile that complies with testing and product requirements of CRI's "Green Label Plus" program.

2.5 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
   1. Adhesives shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Carpet tile at access floor shall be partial glue down such that carpet tiles may be removed and reinstalled for occasional removal of access flooring.

C. Stair Nosing at Lecture Hall (022):
   1. Profile: Johnsonite, Model RCN-XX-A flexible vinyl stair nosing as manufactured by Johnsonite, or approved equal.
   2. Size: 1 15/16" horizontal face / 2" vertical face; designed to accept ¼" or 5/16" material.
   3. Location: Edge of seating risers in Lecture Hall (nosing to run full length of stepped risers).
   4. Color/Finish: Color/Finish shall be as selected by Architect from manufacturer’s full range of standard and premium colors and finishes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects.

B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
   1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
   2. Subfloor finishes comply with requirements specified in Division 03 Section "Cast-in-Place Concrete" for slabs receiving carpet tile.
   3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.

C. For raised access flooring systems, verify the following:
   1. Access floor complies with installation requirements specified in Division 09 Section "Access Flooring."
   2. Access floor substrate is compatible with carpet tile and adhesive if any.
   3. Underlayment surface is flat, smooth, evenly planed, tightly jointed, and free of irregularities, gaps greater than 1/8 inch, protrusions more than 1/32 inch, and substances that may interfere with adhesive bond or show through surface.

D. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION

A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.

C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.

D. Clean metal substrates of grease, oil, soil and rust, and prime if directed by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.

E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer and approved by owner.

C. Maintain dye lot integrity. Do not mix dye lots in same area.

D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.

G. Install pattern parallel to walls and borders.

H. Installation Method: Non Directional or as directed by Architect.

I. Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:
   1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
   2. Remove yarns that protrude from carpet tile surface.

B. Protect installed carpet tile to comply with CRI 104, Section 16, "Protecting Indoor Installations."
C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

3.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 09 68 13
SECTION 09 69 00 - ACCESS FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Access-flooring panels.
   2. Understructure.

B. Related Requirements:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 09 Sections for finish flooring applied over access-flooring panels.
   3. Division 26 Section "Grounding and Bonding for Electrical Systems" for connection to ground of access-flooring understructure.
   4. Division 26 Sections for coordination with cable trays and understructure.
   5. Division 27 Sections for voice and data cabling for service outlets and for coordination with understructure pedestals.

1.3 ALLOWANCES

A. Cutouts in floor panels are required for electrical and data devices in access flooring; coordinate with electrical drawings. Allow for five cutouts.

B. Service outlets are required for electrical and data devices in access flooring; coordinate with electrical drawings. Allow for five devices in access flooring.

1.4 COORDINATION

A. Coordinate location of electrical work in underfloor cavity to prevent interference with access-flooring pedestals.

B. Mark pedestal locations on subfloor using a grid to enable electrical work to proceed without interfering with access-flooring pedestals.

C. Proceed with installation only after completion of other construction within affected spaces.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review connection electrical and data systems.
2. Review and finalize construction schedule and verify availability of materials, Installer’s personnel, equipment, and facilities needed to make progress and avoid delays.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For pedestal-installation adhesives, documentation including printed statement of VOC content.

C. Shop Drawings: Include layout of access-flooring system and relationship to adjoining Work based on field-verified dimensions.
   1. Details and sections with descriptive notes indicating materials, finishes, fasteners, typical and special edge conditions, accessories, and understructures.

D. Samples for Initial Selection: For each type of product and exposed finish.

E. Samples for Verification: For the following products:
   1. One complete full-size floor panel, pedestal, and understructure unit for each type of access-flooring system required.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of access-flooring system, signed by product manufacturer.

C. Seismic Design Calculations: For seismic design of access-flooring systems including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Preconstruction Test Reports: For preconstruction adhesive field test.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Flooring Panels: 10%
   2. Pedestals: 10%

1.9 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals to demonstrate aesthetic effects and to set quality standards for materials and execution.
1. Build mockup of typical access-flooring assembly as shown on Drawings. Size to be an area no fewer than five floor panels in length by five floor panels in width.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install access flooring until spaces are enclosed, subfloor has been sealed, ambient temperature is between 50 and 90 deg F, and relative humidity is not less than 20 and not more than 70 percent.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Access flooring shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Structural Performance: Provide access-flooring systems capable of complying with the following performance requirements according to testing procedures in CISCA's "Recommended Test Procedures for Access Floors":

1. Concentrated Loads: 1250 lbf with the following deflection and permanent set:
   a. Top-Surface Deflection: 0.10 inch.
   b. Permanent Set: 0.010 inch.

3. Rolling Loads: With local or overall deformation not to exceed 0.040 inch.
   a. CISCA Wheel 1: 10 passes 1000 lbf.
   b. CISCA Wheel 2: 10,000 passes 800 lbf.

4. Pedestal Axial Load Test: 6000 lbf.
5. Pedestal Overturning Moment Test: 1000 lbf x inches.
6. Uniform Load Test: 300 lbf/sq. ft. with a maximum top-surface deflection not to exceed 0.040 inch and a permanent set not to exceed 0.010 inch.
7. Drop Impact Load Test: 100 lb.

2.2 MANUFACTURERS

A. Source Limitations: Obtain access-flooring system from single source from single manufacturer.

2.3 FLOOR PANELS

A. Floor Panels, General: Provide modular panels interchangeable with other field panels without disturbing adjacent panels or understructure.

1. Size: Nominal 24 by 24 inches.
2. Attachment to Understructure: Bolted or by gravity to pedestal head. Provide panels with holes drilled in corners to align precisely with threaded holes in pedestal heads and to accept countersunk screws with heads flush with top of panel.

3. One-to-One Carpet Tile: Fabricate panels to accept one-to-one carpet tile.

B. Cementitious-Core Steel Panels: Fabricated from cold-rolled steel sheet, with the die-cut flat top sheet and die-formed and stiffened bottom pan welded together, and with metal surfaces protected against corrosion by manufacturer's standard factory-applied finish. Fully grout internal spaces of completed units with manufacturer's standard cementitious fill.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Tate Access Floor “ConCore 1250 Panel (ConCore Panel 24” with PosiLock Understructure)” or comparable product by one of the following:
   a. ASM Modular Systems, Inc.
   b. Bergvik North America, Inc.
   c. Camino Modular Systems, Inc.
   d. Computer Environments, Inc.
   e. Haworth, Inc.
   f. InterfaceAR.
   g. Maxcess Technologies, Inc.

2.4 UNDERSTRUCTURE

A. Pedestals: Assembly consisting of base, column with provisions for height adjustment, and head (cap); made of steel.
   1. Provide pedestals designed for use in seismic applications.
   2. Base: Square or circular base with not less than 16 sq. in. of bearing area.
   3. Column: Of height required to bring finished floor to elevations indicated. Weld to base plate.
   4. Provide vibration-proof leveling mechanism for making and holding fine adjustments in height over a range of not less than 2 inches and for locking at a selected height, so deliberate action is required to change height setting and prevent vibratory displacement.
   5. Head: Designed to support the panel system indicated.
      a. Provide sound-deadening pads or gaskets at contact points between heads and panels.
      b. Bolted Assemblies: Provide head with four holes aligned with holes in floor panels for bolting of panels to pedestals.

2.5 FLOOR PANEL COVERINGS

A. Provide bare panels without factory-applied floor coverings on traffic surfaces.

2.6 FABRICATION

A. Fabrication Tolerances:
   1. Size: Plus or minus 0.015 inch of required size.
   2. Squareness: Plus or minus 0.015 inch between diagonal measurements across top of panel.
   3. Flatness: Plus or minus 0.035 inch, measured on a diagonal on top of panel.
B. Panel Markings: Clearly and permanently mark floor panels on their underside with panel type and concentrated-load rating.

C. Bolted Panels: Provide panels with holes drilled in corners to align precisely with threaded holes in pedestal heads and to accept countersunk screws with heads flush with top of panel.
   1. Captive Fasteners: Provide fasteners held captive to panels.

D. Cutouts: Fabricate cutouts in floor panels for cable penetrations and service outlets. Provide reinforcement or additional support, if needed, to make panels with cutouts comply with structural performance requirements.
   1. Number, Size, Shape, and Location: As indicated.
   2. Grommets: Where indicated, fit cutouts with manufacturer's standard grommets; or, if size of cutouts exceeds maximum grommet size available, trim edge of cutouts with manufacturer's standard plastic molding with tapered top flange. Furnish removable covers for grommets.
   3. Provide foam-rubber pads for sealing annular space formed in cutouts by cables.

2.7 ACCESSORIES

A. Adhesives: Manufacturer's standard adhesive for bonding pedestal bases to subfloor.
   1. Adhesive shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Post-Installed Anchors: For anchoring pedestal bases to subfloor, provide post-installed anchors as determined to be required by the design criteria conforming with the applicable building codes. The embedment of any post-installed anchor that is required must not exceed 3/4", with the capability to sustain, without failure, a load equal to 1.5 times the loads imposed by pedestal overturning moment on fasteners, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

C. Service Outlets: Standard UL-listed and -labeled assemblies, for recessed mounting flush with top of floor panels; for power, communication, and signal services; and complying with the following requirements:
   1. Structural Performance: Cover capable of supporting a 1000-lbf concentrated load.
   2. Cover and Box Type: Hinged polycarbonate cover with opening for passage of cables when cover is closed and including frame and steel box or formed-steel plate for mounting electrical receptacles. The service outlet box shall be a drop-in design having a hinged lid with carpet inset and frame with tapered edge.
   3. Location: In center of panel quadrant unless otherwise indicated.
   4. Receptacles and Wiring: Electrical receptacles and wiring for service outlets are specified in Division 26 Sections.
   5. Electrical compartments must be separated from the communications compartments by a metal divider.

D. Closures: Where underfloor cavity is not enclosed by abutting walls or other construction, provide metal-closure plates with manufacturer's standard finish.

E. Panel Lifting Device: Panel manufacturer's standard portable lifting device for each type of panel required.

F. Perimeter Support: Where indicated, provide manufacturer's standard method for supporting panel edge and forming transition between access flooring and adjoining floor coverings at same level as access flooring.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer and manufacturer's representative present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Verify that substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, foreign deposits, and debris that might interfere with attachment of pedestals.
   2. Verify that concrete floor sealer and finish have been applied and cured.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Lay out floor panel installation to keep the number of cut panels at floor perimeter to a minimum. Avoid using panels cut to less than 6 inches.

B. Locate each pedestal, complete any necessary subfloor preparation, and vacuum subfloor to remove dust, dirt, and construction debris before beginning installation.

3.3 INSTALLATION

A. Install access-flooring system and accessories under supervision of access-flooring manufacturer's authorized representative to produce a rigid, firm installation that complies with performance requirements and is free of instability, rocking, rattles, and squeaks.

B. Adhesive Attachment of Pedestals: Set pedestals in adhesive, according to access-flooring manufacturer's written instructions, to provide full bearing of pedestal base on subfloor.

C. Mechanical Attachment of Pedestals: Attach pedestals to subfloor with post-installed mechanical anchors with an embedment not to exceed 3/4”.

D. Adjust pedestals to permit top of installed panels to be set flat, level, and to proper height.

E. Install flooring panels securely in place, properly seated with panel edges flush. Do not force panels into place.

F. Scribe perimeter panels to provide a close fit with adjoining construction with no voids greater than 1/8 inch where panels abut vertical surfaces.

G. Cut and trim access flooring and perform other dirt-or-debris-producing activities at a remote location or as required to prevent contamination of subfloor under already-installed access flooring.

H. Clean dust, dirt, and construction debris caused by floor installation, and vacuum subfloor area as installation of floor panels proceeds.

I. Install access flooring without change in elevation between adjacent panels and within the following tolerances:
   1. Plus or minus 1/8 inch in any 10-foot distance.
J. Installed panels shall be spaced so that the distance from one end to the other of any line of 12 panels is not less than 24 feet and does not exceed 24'-1/8".

3.4 PROTECTION

A. Prohibit traffic on access flooring for 24 hours and removal of floor panels for 72 hours after installation to allow pedestal adhesive to set.

B. After completing installation, vacuum access flooring and cover with continuous sheets of reinforced paper or plastic. Maintain protective covering until time of Substantial Completion.

C. Replace access-flooring panels that are stained, scratched, or otherwise damaged or that do not comply with specified requirements.

3.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 09 69 00
SECTION 09 71 00 – INTERIOR METAL SURFACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes:
   1. Aluminum-faced composite wall panels.
   2. Stainless Steel faced composite wall panels.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal-faced surface.
B. Shop Drawings: Show fabrication and installation layouts of metal-faced composite wall and ceiling panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish among factory-, shop-, and field-assembled work.
   1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:
      a. Trim.
      b. Anchorage systems.
C. Samples for Initial Selection: For each type of metal item indicated with factory-applied color finishes.
   1. Include similar Samples of trim and accessories involving color selection.
D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
   1. Metal-Faced Composite Wall Panels: Minimum 12 x 12 inches. Include fasteners, closures, and other metal-faced composite wall panel accessories.
   2. Corrugated Alum Sheet: 12 x 12 inches.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Exterior elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Wall panels and attachments.
2. Girts and Stud framing.
3. Wall-mounted items including doors, windows, louvers, and lighting fixtures.
4. Penetrations of wall by pipes and utilities.

B. Warranties: Samples of special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For all metal items to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Source Limitations: Obtain each type of product from single source from single manufacturer.

C. Aesthetic Effect: The Basis-of-Design Products listed herein establish not only performance standards, but also aesthetic standards which must be met by any other products to be considered an acceptable equal.

D. Mockups: Build mockup for each type of interior metal finish to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical wall and corner panel, including soffit where applicable, as indicated by Architect, including supports, attachments, and accessories.
   a. Include four-way joint for metal-faced composite wall panels.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, metal-faced composite wall panels, and other manufactured items so as not to be damaged or deformed. Package metal-faced composite wall panels for protection during transportation and handling.

B. Unload, store, and erect metal finish products in a manner to prevent bending, warping, twisting, and surface damage.

C. Store metal-faced composite wall panels vertically, covered with suitable weathertight and ventilated covering. Store metal-faced composite wall panels to ensure dryness, with positive slope for drainage of water. Do not store metal-faced composite wall panels in contact with other materials that might cause staining, denting, or other surface damage. Do not allow storage space to exceed 120 deg F.

D. Retain strippable protective covering on metal-faced composite wall panel for period of panel installation.
1.8 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal-faced composite wall panels to be performed according to manufacturer's written instructions and warranty requirements.

B. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before metal-faced composite wall panel fabrication and indicate measurements on Shop Drawings.

1.9 WARRANTY FOR ALUMINUM COMPOSITE PANELS

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal-faced composite wall panel assemblies that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures, including rupturing, cracking, or puncturing.
   b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal-faced composite wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 10 years from date of Substantial Completion.

1.10 WARRANTY FOR STAINLESS STEEL AND CORRUGATED ALUMINUM PANELS

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal-faced composite wall panel assemblies that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures, including rupturing, cracking, or puncturing.
   b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Sheet for Composite Panels: Coil-coated sheet, ASTM B 209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

1. Surface: Smooth, flat finish.
2. Exposed Coil-Coated Finishes:
   a. Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
3. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.2 MISCELLANEOUS METAL FRAMING

A. Zee Clips: 0.079-inch nominal thickness.

2.3 MISCELLANEOUS MATERIALS

A. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. All fasteners to be concealed.

2.4 ALUMINUM-FACED COMPOSITE WALL PANELS

A. General: Provide factory-formed and -assembled, metal-faced composite wall panels fabricated from two metal facings bonded, using no glues or adhesives, to solid, extruded thermoplastic core; formed into profile for installation method indicated. Include attachment system components and accessories.

1. Fire-Retardant Core: Noncombustible, with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   a. Flame-Spread Index: 0.
   b. Smoke-Developed Index: 5.
2. Basis-of-Design Product: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Alcan Composites USA Inc.; Alucobond Plus.

B. Aluminum-Faced Composite Wall Panels: Formed with 0.020-inch-thick, coil-coated aluminum sheet facings.

1. Panel Thickness: 4mm.
2. Core: Fire retardant.
3. Exterior Finish: 3-coat fluoropolymer.
b. Number of Colors: Three.
c. Both solid and metallic colors will be used.

C. Attachment System Components: Formed from extruded aluminum Z-clips as shown on Drawings.

2.5 STAINLESS STEEL FACED COMPOSITE WALL PANELS

A. General: Provide metal-faced composite wall panels fabricated from one layer of stainless steel adhered to fire retardant MDF board. Include attachment system components and accessories.

1. Fire-Retardant Core: Noncombustible, with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   a. Adhere stainless sheet with contact adhesive to ½" thick fire retardant MDF backer board. Refer to Division 06 Section “Interior Architectural Woodwork” for MDF requirements.
   b. Flame-Spread Index: 25 or less.
   c. Smoke-Developed Index: 450 or less.

2. Basis-of-Design Product: Subject to compliance with requirements, available stainless steel sheet finish products include, but are not limited to, the following:
      1) Finish: Seastone.
      2) Thickness: 1.5 mm.
      3) Formed edges and corners.

B. Attachment System Components: Formed from extruded aluminum Z-clips as shown on Drawings.
   1. All fasteners to be concealed.
   2. Refer to the Drawings for attachment details.

2.6 CORRUGATED ALUMINUM PANEL

1. Basis-of-Design Product: Subject to compliance with requirements, available corrugated aluminum sheet finish products include, but are not limited to, the following:
   a. Forms + Surfaces: Bonded Aluminum.
      1) Pattern: Delta.
      2) Thickness: 4.3 mm.
      3) Finish: Natural.

B. Attachment System Components: Formed from extruded aluminum Z-clips as shown on Drawings.
   1. All fasteners to be concealed.
   2. Refer to the Drawings for attachment details.

2.7 FABRICATION

A. General: Fabricate and finish metal-faced composite wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
B. Metal-Faced Composite Wall Panels: Trim and square edges of sheets with no displacement of face sheets or protrusion of core material.

1. Form panel lines, breaks, and angles to be sharp and true, with surfaces free from warp and buckle.
2. Fabricate panels with sharply cut edges, with no displacement of face sheets or protrusion of core material.
3. Fabricate panels with panel stiffeners, as required to comply with deflection limits, attached to back of panels with structural silicone sealant or bond tape.
4. Dimensional Tolerances:
   a. Panel Bow: 0.8 percent maximum of panel length or width.
   b. Squareness: 0.25 inch maximum.

2.8 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal-faced composite wall panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal-faced composite wall panel manufacturer.

2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal-faced composite wall panel manufacturer.

B. Examine roughing-in for components and systems penetrating metal-faced composite wall panels to verify actual locations of penetrations relative to seam locations of panels before panel installation.

C. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 METAL-FACED COMPOSITE WALL PANEL INSTALLATION

A. General: Install metal-faced composite wall panels in orientation, sizes, and locations indicated on Drawings. Anchor panels and other components of the Work securely in place, with provisions for thermal and structural movement, using concealed z-clip system.
   1. Shim or otherwise plumb substrates receiving metal-faced composite wall panels.
   2. No exposed fasteners permitted.

B. Fasteners:
   1. As indicated on the Drawings.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal-faced composite wall panel manufacturer.

D. Attachment System Installation, General: Install attachment system required to support metal-faced composite wall panels and to provide a complete system.

E. Clip Installation: Attach panel clips to supports at each metal-faced composite wall panel joint at locations and spacings recommended by manufacturer. Attach routed-and-returned flanges of wall panels to panel clips with manufacturer's standard fasteners.

3.3 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal-faced composite wall panel units within installed tolerance of 1/4 inch in 20 feet, nonaccumulative, on level, plumb, and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.4 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal-faced composite wall panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal-faced composite wall panel installation, clean finished surfaces as recommended by panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal-faced composite wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

3.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 09 71 00
SECTION 09 84 33 - SOUND-ABSORBING WALL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes shop-fabricated acoustic panel units tested for acoustical performance, including:
   1. Perforated Metal facing for Sound-absorbing wall panels (straight and curved configurations).
   2. Bonded Acoustical Cotton used in sound absorbing wall panels (straight and curved configurations).
B. Related Sections:
   1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 06 Section "Interior Architectural Woodwork".
C. LEED Opportunities: This Section has opportunities for the following LEED points:
   1. Materials and Resources Prerequisite 1 and Credits 2.1, 4.1, 4.2 and 5.1.
   2. Indoor Environmental Quality Credit 4.1.

1.3 DEFINITIONS
A. NRC: Noise Reduction Coefficient.
B. SAA: Sound Absorption Average.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of fabric panel facing, metal facing, core material, and mounting indicated. Submit manufacturer's product data and installation instructions.
B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
   2. Product Certificates for Credit MR 5.1: For products and materials required to comply with requirements for regionally manufactured materials. Include statement indicating
cost, location of manufacturer, and distance to Project for each regionally manufactured material.

C. Shop Drawings: For sound-absorbing wall units. Include mounting devices and details; details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate panel edge and core materials.

1. Include elevations showing panel sizes and direction of fabric weave and pattern matching. Coordinate acoustic panels with Interior Architectural Millwork.
2. Include elevations showing panel sizes for units with perforated metal facings.

D. Samples for Initial Selection: For each type of sound-absorbing wall unit manufacturer's full range.

E. Samples for Verification: For the following products, prepared on Samples of size indicated below:
   1. Fabric: Full-width by approximately 36-inch-long Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied, showing full range of exposed texture to be expected in completed work. Mark top and face of fabric. Coordinate with Interior Architectural Millwork samples.
   2. Perforated Metal: Full-width by approximately 36-inch-long Sample integrated with Bonded Acoustical Cotton core showing full range of exposed texture to be expected in completed work.
   3. Panel Edge: 12-inch-long Sample(s) showing each edge profile, corner, and finish.
   4. Core Material: 12-inch-square Sample at corner.
   6. Assembled Panels: Approximately 36 by 36 inches, including joints and mounting methods.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Electrical outlets, switches, and thermostats.
2. Items penetrating or covered by sound-absorbing wall units including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Alarms.
   e. Sprinklers.
   f. Access panels.

B. Product Certificates: For each type of sound-absorbing wall unit, from manufacturer.

C. Warranty: Sample of special warranty.
1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sound-absorbing wall units to include in maintenance manuals. Include fabric manufacturers’ written cleaning and stain-removal recommendations.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fabric: For each fabric, color, and pattern installed, provide length equal to 10 percent of amount installed, but no fewer than 10 yards.

2. Mounting Devices: Full-size units equal to 5 percent of amount installed, but no fewer than five devices, including unopened adhesives.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain sound-absorbing wall units from single source from single manufacturer.

B. Fire-Test-Response Characteristics: Provide sound-absorbing wall units meeting the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: As determined by testing per ASTM E 84.
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 450 or less.

2. Fire Growth Contribution: Meeting acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 and NFPA 286.

C. Mockups: Build mockups of all acoustic panel units to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials, fabrication, and installation.

1. Build mockup of typical wall area as directed by Architect.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

D. Preinstallation Conference: Conduct conference at Project site.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and sound-absorbing wall unit manufacturers’ written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.
1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not install sound-absorbing wall units until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Do not install sound-absorbing wall units until a permanent level of lighting is provided on surfaces to receive the units.

C. Air-Quality Limitations: Protect sound-absorbing wall units from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.

D. Field Measurements: Verify locations of sound-absorbing wall units and actual dimensions of openings and penetrations by field measurements before fabrication. Field measure curved substrate.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sound-absorbing wall units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to the following:
   b. Fabric sagging, distorting, or releasing from panel edge.
   c. Warping of core.

2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOUND-ABSORBING WALL UNITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Acoustical Panel Systems (APS, Inc.).
2. Acoustical Solutions, Inc.
3. Acoustical Surfaces, Inc.
5. AVL Systems, Inc.
6. Benton Brothers Solutions, Inc.
7. Conwed Designscapes; an Owens Corning company.
8. Decoustics Limited; a CertainTeed Ceilings company.
11. Kinetics Noise Control, Inc.
12. Lamvin, Inc.
13. MBI Products Company, Inc.
14. Panel Solutions, Inc.
17. Proudfoot Company, Inc. (The).
19. Sound Management Group LLC.
20. Tectum Inc.
21. Wall Technology, Inc.; an Owens Corning company.
22. Working Walls, Inc.

B. Sound-Absorbing Wall Panel (Fabric Panel): Manufacturer's standard panel construction consisting of facing material laminated to front face, edges, and back edge border of core or stretched over front face of edge-framed core and bonded or attached to edges and back of frame.

2. Mounting: Edge mounted with splines secured to substrate.
   a. Finish Color at Exposed Edges: As selected by Architect from manufacturer's full range.
3. Mounting: The appropriate hardware as determined most suitable by the manufacturer shall be mounted to the back of the panel.
4. Core: glass-fiber board. Provide wood or plywood nailing strips in core where indicated for the mounting hardware selected by the manufacturer.
   a. Core-Face Layer: Manufacturer's standard tackable, impact-resistant, high-density board or impact-resistant, acoustically transparent, copolymer sheet.
5. Edge Construction: Manufacturer's standard chemically hardened frame.
6. Edge Profile: Square profile as indicated on Drawings.
7. Corner Detail in Elevation: Square with continuous edge profile indicated.
8. Reveals between Panels: reveals as selected by Architect from manufacturer's full range or as indicated on Drawings.
10. Acoustical Performance: Sound absorption NRC or SAA of not less than 0.65 according to ASTM C 423 for Type A mounting according to ASTM E 795.
12. Panel Width: As indicated on Drawings.
13. Panel Height: As indicated on Drawings.

C. Sound-Absorbing Wall Panel (Perforated Metal Panel): Manufacturer's standard panel construction.

3. Mounting: The appropriate hardware as determined most suitable by the manufacturer shall be mounted to the back of the panel.
4. Core: Bonded Acoustical Cotton
5. Edge Construction: Manufacturer's standard
6. Edge Profile: Square profile as indicated on Drawings.
7. Corner Detail in Elevation: Square with continuous edge profile indicated.
8. Reveals between Panels: reveals as selected by Architect from manufacturer's full range or as indicated on Drawings.
10. Nominal Overall Panel Thickness: 2 inches.
11. Panel Width: As indicated on Drawings.
12. Panel Height: As indicated on Drawings.

2.2 MATERIALS

A. General:
   1. Minimum Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent by weight.
   2. Regional Materials: Sound-absorbing wall units shall be manufactured within 500 miles of Project site.
   3. Certified Wood: Fabricate products with wood-based components produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

B. Core Materials (Fabric Panel):
   1. Glass-Fiber Board: ASTM C 612, Type standard with manufacturer; nominal density of 6 to 7 lb/cu. ft., unfaced, and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
   2. Tackable, Impact-Resistant, High-Density Board for Face Layer: 1/8-inch-thick layer of compressed molded glass-fiber board with a nominal density of 16 to 18 lb/cu. ft. laminated to face of core.
   3. Impact-Resistant, Acoustically Transparent, Copolymer Sheet for Face Layer: 1/16- to 1/8-inch-thick layer of perforated, noncombustible, copolymer sheet laminated to face of core.

C. Core Materials (Perforated Metal Panels):
   1. Bonded Acoustic Cotton:

D. Facing Material (Fabric Panel): Fabric from same dye lot; color and pattern as selected by Architect from manufacturer's full range.

E. Mounting Devices: Concealed on back of unit, recommended by manufacturer to support weight of unit, and as follows:
   1. Adhesives: As recommended by sound-absorbing wall unit manufacturer and with a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart DEPA Method 24).
   2. Metal Clips or Bar Hangers: If determined by Manufacturer to be the most suitable mounting installation and approved in Shop Drawings, Manufacturer's standard two-part metal "Z" clips, with one part of each clip mechanically attached to back of unit and the other part to substrate, designed to permit unit removal.

2.3 FABRICATION

A. General: Use manufacturer's standard construction except as otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.
   1. Glass-Fiber Board Cores (Fabric Panel): Chemically harden core edges and areas of core where mounting devices are attached.

B. Core-Face Layer (Fabric Panels): Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, or sags.

C. Facing Material (Fabric Panels): Apply fabric facing fully covering visible surfaces of unit; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.
   1. Square Corners: Tailor corners.
   2. Radius and Other Nonsquare Corners: Attach facing material so there are no seams or gathering of material.
   3. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent units.

D. Facing Material (Perforated Metal):
   1. Square Corners.
   2. Perforations in metal to be square and plumb at each individual unit and adjacent units.

E. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch for the following:
   1. Thickness.
   2. Edge straightness.
   3. Overall length and width.
   4. Squareness from corner to corner.
   5. Chords, radii, and diameters.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fabric, fabricated units, substrates, areas, and conditions, for compliance with requirements, installation tolerances, and other conditions affecting performance of sound-absorbing wall units.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install sound-absorbing wall units in locations indicated with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Comply with sound-absorbing wall unit manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.

C. Align and level fabric pattern and grain among adjacent units.
3.3 INSTALLATION TOLERANCES

A. Variation from Plumb and Level: Plus or minus 1/16 inch.

B. Variation of Panel Joints from Hairline: Not more than 1/32 inch wide.

3.4 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

3.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:

   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:

   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 09 84 33
SECTION 09 91 23 – PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on the following interior substrates:
   1. Concrete.
   2. Concrete masonry units (CMU).
   3. Steel.
   5. Aluminum (not anodized or otherwise coated).
   6. Wood.
   7. Gypsum board.
   8. Plaster.

B. Related Requirements:
   1. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
   2. Division 06 Sections for shop priming carpentry with primers specified in this Section.

C. Surfaces to be Painted: Except where natural or clear finish of material is specifically noted as a surface not to be painted, paint all interior and exterior new and existing exposed surfaces whether or not painting is designated on drawings.
   1. Where items or surfaces are not specifically mentioned, paint the same as similar adjacent materials or areas after first obtaining direction from the Architect. If color or finish is not designated, Architect will select these from finishes available, and provide color sample for custom color matching.
   2. Paint (or stain, as indicated) all six sides of all doors.
   3. Paint concealed miscellaneous ironwork, which is not stainless steel, copper, galvanized, or insulated, except as otherwise indicated.
   4. Paint all mechanical, electrical, fire protection, and plumbing piping exposed to view in public spaces. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, fire protection pipes, conduits, junction boxes, etc., and surfaces of mechanical and electrical equipment that do not have a factory-applied final finish.
   5. Surfaces indicated on Drawings to receive Projection Screen Paint.

D. Unless otherwise indicated, do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
   1. Prefinished items include but are not limited to the following factory-finished components:
      a. Architectural woodwork.
      b. Hardware.
      c. Satin Finished Stainless Steel.
      d. Aluminum entrances, storefront, and curtain wall.
      e. Acoustical panels.
      f. Pre-finished louvers and vents.
      g. Finished mechanical and electrical equipment.
h. Light fixtures.
i. Miscellaneous items with baked-on powder coats.
j. Overhead rolling doors.
k. Acoustical plaster.
l. Elevator entrance doors, frames and elevator equipment scheduled for stainless steel finishes.
m. Prefinished insulated metal panels.
n. Zinc/tin coated copper roof, trim and flashing.
o. Prefinished aluminum extrusions used as exterior trim.

2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
a. Foundation spaces.
b. Furred areas.
c. Ceiling plenums, except for areas above “floating” ceilings when area is partially exposed.
d. Pipe spaces.
e. Duct shafts.
f. Elevator shafts.

3. Finished metal surfaces include the following:
a. Anodized aluminum.
b. Stainless steel.
c. Chromium plate.
d. Copper and copper alloys.
e. Bronze and brass.
f. Metal surfaces indicated to receive fluoropolymer (Duranar or Kynar) coating finish.

4. Operating parts include moving parts of operating equipment and the following:
a. Valve and damper operators.
b. Linkages.
c. Sensing devices.
d. Motor and fan shafts.

5. Labels: Do not paint over Underwriters’ Laboratories (UL), Factory Mutual Global (FMG), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

E. Work under this contract shall also include, but not necessarily be limited to:
1. Moisture testing of substrates.
2. Surface preparation of substrates as required for acceptance of paint, including cleaning, small crack repair, patching, caulking, and making good surfaces and area to the limits defined under MPI Repainting Manual Preparation requirements.
3. Specific pre-treatments noted herein or specified in the MPI Repainting Manual.
4. Sealing/priming surfaces for repainting in accordance with the MPI Repainting Manual requirements.

F. The material and installation shall conform to the applicable building code requirements of all authorities having jurisdiction.

1.3 DEFINITIONS

A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. LEED Submittals:
   1. Product Data for Credit EQ 4.2: For paints and coatings, including printed statement of VOC content.

C. Samples for Initial Selection: For each type of topcoat product.

D. Samples: Prior to beginning work, Architect will furnish color chips for surfaces to be painted. Use representative colors to match Architect’s chips when preparing samples for review. Submit samples for Architect’s review of color and texture only. Provide a listing of material and application for each coat of each finish sample.
   1. On 12” x 12” hardboard, provide two samples of each color and material, with texture to simulate actual conditions. Resubmit samples as requested by Architect until acceptable sheen, color and texture is achieved.
   2. On concrete masonry, provide two 4” square samples of masonry for each type of finish and color, defining filler, prime and finish coats.
   3. On actual wall surfaces and other building components, duplicate painted finishes of prepared samples. Provide full coat finish samples on at least 100 sq. ft. of surface, as directed, until required sheen color and texture is obtained; simulate finished lighting conditions for review of in-place work.
   4. For non-ferrous and ferrous metal, provide two 4-inch square samples of flat metal and two 8 inch long samples of solid metal for each color and finish.
   5. Final acceptance of colors will be from samples applied on the job.

E. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
   1. Submit Samples on rigid backing, 8 inches square.
   2. Step coats on Samples to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

F. Product List: For each product indicated, include the following:
   1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
   2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.
   3. VOC content.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.
1.6 QUALITY ASSURANCE

A. MPI Standards:
   1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."

B. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

C. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
      a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft..
      b. Other Items: Architect will designate items or areas required.
   2. Apply benchmark samples after permanent lighting and other environmental services have been activated.
   3. Final approval of color selections will be based on benchmark samples.
      a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.

D. Credit EQ 4.2: Provide anti-corrosive and anti-rust paints to interior ferrous metal substrates that do not exceed VOC limit of 250g/L established in Green Seal Standard GS-03, Anti-Corrosive Paints, second edition, January 7, 1997.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Benjamin Moore & Co.
   3. Cloverdale Paint.
5. Duron, Inc.
6. Insl-x.
8. PPG Architectural Finishes, Inc.
10. Tnemec.

B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to products listed in other Part 2 articles for the paint category indicated.

2.2 PAINT, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. Material Compatibility:
   1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   1. Flat Paints and Coatings: 50 g/L.
   2. Nonflat Paints and Coatings: 150 g/L.
   3. Dry-Fog Coatings: 400 g/L.
   4. Primers, Sealers, and Undercoaters: 200 g/L.
   5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
   7. Pretreatment Wash Primers: 420 g/L.
   8. Floor Coatings: 100 g/L.
   9. Shellacs, Clear: 730 g/L.
   10. Shellacs, Pigmented: 550 g/L.

D. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
   1. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
   2. Restricted Components: Paints and coatings shall not contain any of the following:
      a. Acrolein.
      b. Acrylonitrile.
      c. Antimony.
      d. Benzene.
      e. Butyl benzyl phthalate.
      f. Cadmium.
      g. Di (2-ethylhexyl) phthalate.
      h. Di-n-butyl phthalate.
      i. Di-n-octyl phthalate.
      j. 1,2-dichlorobenzene.
      k. Diethyl phthalate.
      l. Dimethyl phthalate.
m. Ethylbenzene.
n. Formaldehyde.
o. Hexavalent chromium.
p. Isophorone.
q. Lead.
r. Mercury.
s. Methyl ethyl ketone.
t. Methyl isobutyl ketone.
u. Methylene chloride.
v. Naphthalene.
w. Toluene (methylbenzene).
x. 1,1,1-trichloroethane.
y. Vinyl chloride.

E. Colors: Provide multiple custom colors for each substrate indicated as selected by Architect.

2.3 BLOCK FILLERS

   1. VOC Content: E Range of E3.

2.4 PRIMERS/SEALERS

A. Interior Latex Primer/Sealer: MPI #50.
   1. VOC Content: E Range of E2.

B. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in paint systems indicated.

2.5 METAL PRIMERS

A. Refer to Paint Schedule in Part 3 of this Section for product information.

2.6 WOOD PRIMERS

A. Interior Latex-Based Wood Primer: MPI #39.
   1. VOC Content: E Range of E3.
   2. Environmental Performance Rating: EPR 3.

2.7 LATEX PAINTS

A. Institutional Low-Odor/VOC Latex (Flat): MPI #143 (Gloss Level 1).
   1. VOC Content: E Range of E3.

B. Institutional Low-Odor/VOC Latex (Eggshell): MPI #144 (Gloss Level 2).
   1. VOC Content: E Range of E3.
   2. Environmental Performance Rating: EPR 4.5.

C. Institutional Low-Odor/VOC Latex (Semigloss): MPI #147 (Gloss Level 5).
   1. VOC Content: E Range of E3.
   2. Environmental Performance Rating: EPR 5.5.

2.8 EPOXY PAINTS

A. Refer to Paint Schedule in Part 3 of this Section for product information.
2.9 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
   1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
   2. Testing agency will perform tests for compliance with product requirements.
   3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Concrete: 12 percent.
   3. Wood: 15 percent.
   4. Gypsum Board: 12 percent.
   5. Plaster: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Plaster Substrates: Verify that plaster is fully cured.

E. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

F. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Proper product selection, surface preparation, and application affect coating performance. Coating integrity and service life will be reduced because of improperly prepared surfaces. Selection and implementation of proper surface preparation ensures coating adhesion to the substrate and prolongs the service life of the coating system.

C. The surface must be dry and in sound condition. Remove oil, dust, dirt, and loose rust, peeling paint or other contamination to ensure good adhesion. Schedule cleaning and painting so that dust and other contaminants from the cleaning process will not fall onto wet, newly painted surfaces.
D. Remove mildew before painting by washing with a solution of 1 part liquid household bleach and 3 parts of warm water. Apply the solution and scrub the mildewed area. Allow the solution to remain on the surface for 10 minutes. Rinse thoroughly with clean water and allow the surface to dry 48 hours before painting. Wear protective glasses or goggles, waterproof gloves, and protective clothing. Quickly wash off any of the mixture that comes in contact with your skin. Do not add detergents or ammonia to the bleach/water solution.

E. No exterior painting should be done immediately after a rain, during foggy weather, when rain is predicted, or when the temperature is below 50°F unless the specified product is designed for the marginal conditions.

F. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
1. Provide barrier coats over incompatible primers or remove and reprime as required. Check for compatibility by applying a test patch of the recommended coating system, covering at least 2 to 3 square feet. Allow to dry one week before testing adhesion per ASTM D3359. If the coating system is incompatible, complete removal is required. Notify Architect in writing of any anticipated problems in using the specified coating systems with substrates primed by others.
2. Cementitious Materials: Prepare concrete and concrete unit masonry to be painted by removing efflorescence, chalk, dust, dirt, grease, oils, and by roughening as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
   a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.
   b. Determine alkalinity and moisture content of surfaces to be painted by performing appropriate tests. If surfaces are found to be sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application of paint. Do not paint surfaces if moisture content exceeds that permitted in manufacturer's printed directions.
3. Existing Drywall or Plaster:
   a. Remove all peeling or scaling paint by scraping. Sand areas thoroughly to feather edge smooth with adjacent surface.
   b. Cracks, holes and blemished areas are to be filled and sanded flush with adjacent surfaces, then spot primed with finish coating.
   c. All surfaces must be free of sanding dust, and joint treatment cement should be thoroughly dry.
   d. Damaged or defective surfaces are to be repaired by spackling or by other appropriate measures.
   e. Glossy surfaces are to be dulled by sanding lightly with 180-grit sandpaper.
   f. All surfaces must be thoroughly dry and clean.
   g. Cracks, voids and abrasions must be spackled and finished in the same wall texture and finish flush to the adjoining surfaces. Repaired surfaces are to be spot-primed with appropriate prime sealer before applying an overall coat of the same.
4. Ferrous Metals: Clean ferrous surfaces, including galvanized or shop-coated surfaces, of oil, grease, dirt, loose mill scale, spatter, slag, flux deposits, and other foreign substances by solvent or mechanical cleaning.
   a. Touch-up shop-applied prime coats wherever damaged or bare, where required by other sections of these specifications. Clean and touch-up with same type shop primer.
   b. Galvanized Metal: Clean per SSPC-SP1 using detergent and water or a degreasing cleaner to remove greases and oils. Apply a test area, priming as required. Allow the coating to dry at least one week before testing. If adhesion is poor, Brush Blast per SSPC-SP7 is necessary to remove these treatments.
   c. All interior and exterior ferrous metals exposed in finished construction shall be cleaned in accordance with Steel Structures Painting Council (SSPC). Visual standards are available through the Steel Structures Painting Council; ask for SSPC-VIS 1-89.
1) **Commercial Blast Cleaning, SSPC-SP6 or NACE 3** - for structural steel and all partially or fully exposed interior and exterior ferrous metal, except for interior ferrous metal pipe and bar railings and metal pan stairs, clean to attain an average profile depth of 1.5 mils. A Commercial Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except for staining. Staining shall be limited to no more than 33 percent of each square inch of surface area and may consist of light shadows, slight streaks, or minor discoloration caused by stains of rust, stains of mill scale, or stains of previously applied paint. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods.

d. **Interior and exterior ferrous metals not exposed to finished construction shall be cleaned in accordance with Steel Structures Painting Council (SSPC).** Visual standards are available through the Steel Structures Painting Council; ask for SSPC-VIS 1-89.

1) **Solvent Cleaning, SSPC-SP1:** Solvent cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants. Solvent cleaning does not remove rust or mill scale. Change rags and cleaning solution frequently so that deposits of oil and grease are not spread over additional areas in the cleaning process. Be sure to allow adequate ventilation.

e. **All foundry and mill marks shall be removed by grinding or other approved method, and surfaces finished smooth and flush.** Any marks showing through finished work shall be removed and the entire surface of item repainted at no additional cost to the Owner. Spot touch-up on finish coats will not be accepted.

G. **Remove plates, machined surfaces, and similar items already in place that are not to be painted.** If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

H. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

I. **Concrete Substrates:** Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

J. **Concrete Masonry Substrates:** Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

K. **Steel Substrates:** Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.

L. **Galvanized-Metal Substrates:** Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

M. **Wood Substrates:**

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler.
   Sand smooth when dried.

N. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.

O. Plaster Substrates: Do not begin paint application until plaster is fully cured and dry.

P. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
   1. Use applicators and techniques suited for paint and substrate indicated.
   2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
   3. The term "exposed surfaces" include areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
   4. Provide finish coats that are compatible with prime coats used.
   5. Apply ADDITIONAL coats when undercoats, stains, or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Give special attention to insure that surfaces, including edges, corners, crevices and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
   6. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
   7. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non specular black paint. Pint exterior surface of exposed ducts.
   8. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
   9. If not factory-finished, finish interior and exterior doors on tops, bottoms, and side edges same as faces.
   10. Sand lightly between each succeeding enamel or varnish coat.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
   1. Mechanical Work:
      a. Uninsulated metal piping.
      b. Uninsulated plastic piping.
      c. Pipe hangers and supports.
d. Tanks that do not have factory-applied final finishes.
e. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
g. Mechanical equipment that is indicated to have a factory-primed finish for field painting.

2. Electrical Work:
   a. Switchgear.
   b. Panelboards.
   c. Electrical equipment that is indicated to have a factory-primed finish for field painting.

3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
   1. Contractor shall touch up and restore painted surfaces damaged by testing.
   2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

A. CMU Substrates:
   1. Institutional Low-Odor/VOC Latex System: MPI INT 4.2E.

B. Steel Substrates: Roof Steel, not including acoustical deck:
   1. Semi-Gloss Zinc/Epoxy/Urethane Finish: 2 coats over primer
      a. Zinc-Rich Primer
         1) When not specified otherwise, for shop applied on surfaces blast cleaned in the shop (2.5 – 3.5 mils): Tnemec, Series 90-97 or Equal.
         2) For field primed (2.4 – 3.5 mils): Tnemec, Series 94-H2O Hydro-Zinc or equal.
      b. First Coat:
         1) Tnemec, Series L69 Epoxoline (3-5 mils).
         2) Or equal.
      c. Second Coat:....
1) Tnemec, Series 1081 WB Endura-Shield (2-3 mils).
2) Or equal.

C. Steel Substrates: Acoustic and Non-Acoustic Metal Deck:
1. Low VOC Semi-Gloss Zinc/Epoxy/Urethane Non-Bridging Finish:
   a. Primer: Manufacturer’s factory-applied epoxy primer and oven-cured polyester topcoat, unless otherwise noted.
   b. First Finish Coat:
      1) Tnemec: L69, Epoxoline (3-5 mils)
      2) Or equal.
   c. Second Finish Coat:
      1) Tnemec: Series 750 Endura-Shield, (3-4 mils)
      2) Or equal.

D. Steel Substrates: Decorative Metal and all other Ferrous Metal:
1. Low VOC Semi-Gloss Zinc/Epoxy/Urethane Finish: 2 finish coats over primer.
   a. Zinc-Rich Primer:
      1) For Shop or Field Primed (2.5 – 3.5 mils): Tnemec, Series 94-H2O Hydro-Zinc or equal.
      2) First Coat:
         1) Tnemec, Series L69 or L69F Epoxoline (3-5 mils).
         2) Or equal
      c. Second Coat:
         1) Tnemec, Series 750 Endura-Shield (3-4 mils).
         2) Or equal.

E. Steel Substrates: AESS where indicated:
1. Low VOC Semi-Gloss Zinc/Epoxy/Urethane Finish: 2 finish coats over primer.
   a. Zinc-Rich Primer:
      1) For Shop or Field Primed (5-6 mils): Tnemec, Series L-69 Hi-Build Epoxoline II or equal.
      2) First Coat:
         1) Tnemec, Series V701 Hydroflon (2-3 mils).
         2) Or equal
      c. Second Coat:
         1) Tnemec, Series V701 Hydroflon (2-3 mils).
         2) Or equal.

F. Galvanized-Metal Substrates:
1. Low VOC Semi-Gloss Zinc/Epoxy/Urethane Finish: 2 finish coats over primer.
   a. Self-Priming First Coat:
      1) Tnemec, Series L69 or L69F Epoxoline (4-6 mils).
      2) Or equal
   b. Second Coat:
      1) Tnemec, Series 750 Endura-Shield (3-4 mils).
      2) Or equal.

G. Aluminum Substrates: Decorative Metal and Metal Fabrications:
   a. Primer: (0.7-1.3 mils) Sherwin-Williams DTM Wash Primer, or equal.
   b. First Coat: (2.5-4.0 mils) Sherwin-Williams DTM Acrylic Coating, or equal.
   c. Second Coat: (2.5-4.0 mils) Sherwin-Williams DTM Acrylic Coating, or equal.

H. Wood Panel Substrates and Wood Furring for Matte Black Paint Finish (e.g. Flipper Carrels, semi-exposed furring and blocking): Including painted plywood.
1. Institutional Low-Odor/VOC Latex System: MPI INT 6.4T.
b. Intermediate Coat: Institutional Low Odor/VOC, Flat (MPI Gloss Level 1), MPI #143.
c. Topcoat: Institutional Low Odor/VOC, Flat (MPI Gloss Level 1) MPI # 143.

I. Wood Panel Substrates, for typical conditions, including painted plywood.
   1. Institutional Low-Odor/VOC Latex System: MPI INT 6.4T.

J. Wood Substrates: Including wood trim, but not including Interior Architectural Woodwork.
   1. Institutional Low-Odor/VOC Latex System:
      a. Prime Coat: Primer, latex, for interior wood, MPI #39.
      c. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (Gloss Level 5), MPI #147.

K. Gypsum Board Substrates, for walls bathrooms:
   1. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.
      a. Prime Coat: Interior latex primer/sealer, MPI #149.
      c. Topcoat: Institutional low-odor/VOC interior latex (semi-gloss), MPI# 147.

L. Gypsum Board Substrates, for walls in typical conditions:
   1. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.
      a. Prime Coat: Interior latex primer/sealer, MPI #149.
      c. Topcoat: Institutional low-odor/VOC interior latex (eggshell), MPI #144.

M. Gypsum Board Substrates, for ceilings in typical conditions:
   1. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.
      a. Prime Coat: Interior latex primer/sealer, MPI#149.
      c. Topcoat: Institutional low-odor/VOC interior latex (flat), MPI#143.

N. Gypsum Board Substrates, for Projection Wall in Lecture Hall:
      a. Reflective Base Coat #1: CRT White.
      b. Reflective Base Coat #2: CRT White.
      c. Diffusive Top Coat # 1: CRT White.
      d. Diffusive Top Coat #2: CRT White.

O. Gypsum Board Substrates concealed by tackboard surfaces:
   1. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.
      a. Prime Coat: Interior latex primer/sealer, MPI #149.

P. Plaster Substrates, for ceiling surfaces:
   1. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.
      a. Prime Coat: Interior latex primer/sealer. MPI#149.

Q. Cotton or Canvas Insulation-Covering Substrates: Including pipe and duct coverings.
   1. Institutional Low-Odor/VOC Latex System: MPI INT 10.1D.
      a. Prime Coat: Interior latex primer/sealer. MPI#50.

3.7 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 09 91 23
SECTION 10 11 00 - VISUAL DISPLAY SURFACES  [C]

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Chalkboards.
   2. Resilient linoleum tackable wall surface.

B. Related Sections:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 9 Section "Gypsum Board" for Visual display rails and Custom chalk rails.

C. LEED Opportunities: This Section has opportunities for the following LEED points:
   1. Materials and Resources Prerequisite 1 and Credits 2.1, 4.1, 4.2 and 5.1.
   2. Indoor Environmental Quality Credit 4.1.

1.3 DEFINITIONS

A. Visual Display Board Assembly: Visual display surface that is factory fabricated into composite panel form, either with or without a perimeter frame; includes chalkboards, markerboards, and tackboards.

B. Visual Display Surface: Surfaces that are used to convey information visually, including surfaces of chalkboards, markerboards, tackboards, and surfacing materials that are not fabricated into composite panel form but are applied directly to walls.

C. Tackable wall surface: Framed or unframed tackable surface.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for visual display surfaces.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.
2. Product Data for Credit IEQ 4.4: For composite wood products, documentation indicating that the product contains no urea formaldehyde.

3. Credits MR 4.1 and MR 4.2: Product Data indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
   a. Include statement indicating costs for each product having recycled content.

4. Refer to Division 1 Section "Sustainable Design Requirements" for additional submittal requirements.

C. Shop Drawings: For visual display surfaces. Include plans, elevations, sections, details, and attachments to other work.
   1. Show locations of panel joints.
   2. Include sections of typical trim members.

D. Samples for Initial Selection: For each type of visual display surface indicated, for units with factory-applied color finishes, and as follows:
   1. Actual sections of porcelain-enamel face sheet.
   2. Include accessory Samples to verify color selected.
   3. Actual samples of manufacturer's full range of colors for resilient linoleum tackable wall surfaces.

E. Samples for Verification: For each type of visual display surface indicated.
   1. Visual Display Surface: Not less than 8-1/2 by 11 inches, mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
   2. Trim: 6-inch-long sections of each trim profile.
   3. Accessories: Full-size Sample of each type of accessory.
   4. Tackable Wall Surface: Not less than 8 ½ by 11 inches (215 by 280 mm) for each type, color and texture required.

F. Product Schedule: For visual display surfaces. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of fabrics.

C. Warranties: Sample of special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For visual display and tackable wall surfaces to include in maintenance manuals.
1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain visual display surfaces from single source from single manufacturer.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate appearance and aesthetic effects and set quality standards for installation.
   1. Build mockup of typical wall area as shown on Drawings. Include accessories.
   2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

D. Preinstallation Conference: Conduct conference at Project site.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-built visual display surfaces, including factory-applied trim where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefabricate components at the factory, disassemble for delivery, and make final joints at the site.

B. Store visual display surfaces vertically with packing materials between each unit.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install visual display surfaces until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Field Measurements: Verify actual dimensions of construction contiguous with visual display surfaces by field measurements before fabrication.

   1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

1.10 WARRANTY

A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.

   1. Failures include, but are not limited to, the following:
      a. Surfaces lose original writing and erasing qualities.
b. Surfaces become slick or shiny.
c. Surfaces exhibit crazing, cracking, or flaking.

2. Warranty Period: 50 years from date of Substantial Completion.

B. Special Warranty for Tackable Wall Surfaces: Manufacturer's standard form in which manufacturer agrees to repair or replace tackable wall surfaces that fail in materials or workmanship within specified warranty period.

1. Warranty Period: A minimum of 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Porcelain-Enamel Face Sheet: Porcelain-enamel-clad, ASTM A 463/A 463M, Type 1, stretcher-leveled aluminized steel, with 0.024-inch uncoated thickness; with porcelain-enamel coating fused to steel at approximately 1000 deg F.

1. Matte Finish: Low reflective; chalk wipes clean with dry cloth or standard eraser.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) Claridge Products and Equipment, Inc.; Vitracite Chalkboard.

B. Particleboard: ANSI A208.1, Grade M-1, made with binder containing no urea formaldehyde.

C. Extruded Aluminum: ASTM B 221, Alloy 6063.

D. Resilient Linoleum Tackable Surface: Uni-color linoleum resilient homogeneous tackable surface consisting of linseed oil, granulated cork, rosin binders and dry pigments calendared onto a natural burlap backing. Color shall extend through thickness of material.

1. Basis of Design: Subject to compliance with requirements, provide “Forbo Bulletin Board,” as manufactured by Forbo International, Humboldt Industrial Park, P.O. Box 667, Hazleton, PA 18201; Telephone: 800 842 7839, 570 459 0771; Fax: 570 450 0258. www.forboflooring.na.com, or approved equal.

2.2 CHALKBOARD ASSEMBLIES

A. Porcelain-Enamel Chalkboards: Balanced, high-pressure, factory-laminated chalkboard assembly of three-ply construction consisting of backing sheet, core material, and porcelain-enamel face sheet with matte finish.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Claridge Products and Equipment, Inc.
2. Particleboard Core: 7/16 inch thick; with 0.005-inch-thick, aluminum foil backing. ANSI A208.1, Grade M-1, made with binder containing no urea formaldehyde.

3. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.

4. Extruded Aluminum: ASTM B 221, Alloy 6063.

2.3 TACKABLE WALL SURFACE FOR DIRECT APPLICATION

A. Manufacturers:
   1. Forbo Industries, Inc., Hazleton, PA, or alternative manufacturer as approved by Architect.

   1. Colors: As selected by Architect from the full range of manufacturer's standard and custom colors. Three colors will be required.

C. Gauge: ¼ inch thick.

D. Widths: 48 inch and 72 inch, as required by dimensions indicated in Drawings.

E. Material Length: Supply material in one piece to cover extent of surface indicated.

F. Backing: Burlap.

G. Flexibility: Will not crack or bend when bent around a 2 ¾ inch diameter cylinder.

H. Fire Resistance: ASTM E-84 – Class B / NFPA 255 – Class II.

I. Dimensional Stability: Dimensionally stable in all directions. Resistant to cracking, peeling and drying.

J. Self-healing: Ability to self-heal from thumbtack and push pin punctures.

K. Light Reflectance/Finish: Provide matte finish material to minimize reflection from surface.

L. Adhesive: Manufacturer's standard adhesive for adhering tackable wall material to wall surface.

M. Factory Cut Edges: Where two or more sections of tackable wall surface are butted together, either vertically or horizontally, provide factory cut edge to form tight, hairline joint without the need for applied trim.

N. Beveled Edges: At all perimeter exposed edges, provide beveled (eased) edge. [C]

2.4 FABRICATION

A. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.

B. Visual Display Boards: Field assemble visual display boards unless otherwise indicated.

   1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display boards at manufacturer's factory before shipment.
2.5 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

B. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer’s written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

B. Examine walls and partitions for proper preparation and backing for visual display surfaces.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with manufacturer’s written instructions for surface preparation.

B. Clean substrates of substances that could impair the performance of and affect the smooth, finished surfaces of visual display boards, including dirt, mold, and mildew.

C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display surfaces and wall surfaces.

1. Prepare substrates indicated to receive visual display wall covering as required by manufacturer's written instructions to achieve a smooth, dry, clean, structurally sound surface that is uniform in color.
a. Moisture Content: Maximum of 4 percent when tested with an electronic moisture meter.
b. Plaster: Allow new plaster to cure. Neutralize areas of high alkalinity. Prime with primer as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
c. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
d. Painted Surfaces: Treat areas susceptible to pigment bleeding.

3.3 INSTALLATION, GENERAL

A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

1. Mounting Height: 36 inches above finished floor to top of chalktray, unless otherwise indicated.

3.4 INSTALLATION OF FIELD-FABRICATED VISUAL DISPLAY BOARDS AND ASSEMBLIES FOR WALL-TO-WALL APPLICATION

A. Field-Assembled Visual Display Units: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.

1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, as indicated on approved Shop Drawings.
2. Provide manufacturer’s standard vertical-joint spline system between abutting sections of chalkboards.
3. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer’s standard structural support accessories to suit conditions indicated.

B. Locations as shown in Drawings, including but not limited to classrooms, multi-purpose event spaces, conference rooms, meeting/work rooms, etc. [C]

3.5 INSTALLATION OF FACTORY-FABRICATED VISUAL DISPLAY BOARDS AND ASSEMBLIES, WHERE INDICATED

A. Visual Display Boards: Attach visual display boards to wall surfaces with adhesive gobs at 16 inches o.c., horizontally and vertically.

B. Visual Display Boards: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than 16 inches o.c. Secure both top and bottom of boards to walls.

1. Field-Applied Aluminum Trim: Attach trim over edges of visual display boards and conceal grounds and clips. Attach trim to boards with fasteners at not more than 24 inches o.c.
   a. Attach chalktrays to boards with fasteners at not more than 12 inches o.c.
3.6 INSTALLATION OF TACKABLE WALL SURFACE

A. Install tackboard surfaces to wall surfaces and architectural woodwork substrates indicated in the Drawings, according to the tackboard surface manufacturer’s instructions.

B. Allow substrate and tackboard surface to acclimate to occupancy temperatures and humidity for 72 hours prior to lamination or fabrication.

C. Follow manufacturer’s recommendations for seaming.

D. Install material at locations and elevations indicated, with seams horizontal and level.

E. Butt factory cut seams where two sections meet, with no gaps or overlaps. Remove air bubbles, wrinkles, blisters, and other defects.

F. Conduct an adhesion material bond test prior to fabrication.

G. Apply tackboard surface manufacturer’s recommended adhesive according to instructions with recommended applicators. Apply tackboard surface to substrate and roll, cold press or hot press thoroughly.

H. Install tackboard surfaces in a manner that will not strip or harm the factory finish of the tackboard surface.

I. Follow tackboard surface manufacturer’s recommendations for cleaning, allowing the recommended duration after installation onto substrate to achieve an adequate bond and cure before conducting wet cleaning procedures.

J. Fabricate tackboard panels with edge treatment indicated in Drawings.

3.7 CLEANING AND PROTECTION

A. Clean visual display surfaces according to manufacturer’s written instructions. Attach one cleaning label to visual display surface in each room.

B. Touch up factory-applied finishes to restore damaged or soiled areas.

C. Cover and protect visual display surfaces after installation and cleaning.

3.8 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:

1. Aluminum
2. Plastic Materials and Gaskets
3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 10 11 00
SECTION 10 14 00 – SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Dimensional characters (letters and numbers) for interior and exterior use and the hardware to install characters.

B. Related Sections include the following:
   1. Division 01 Section "Temporary Facilities and Controls" for temporary Project identification signs and for temporary information and directional signs.
   2. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
   3. Division 10 Section "Directories" for building directories.
   4. Division 14 Section for code-required elevator signage.
   5. Division 23 Identification for HVAC Piping and Equipment" for labels, tags, and nameplates for HVAC systems and equipment.
   6. Division 26 Section "Identification for Electrical Systems" for labels, tags, and nameplates for electrical equipment.
   7. Division 26 Section "Interior Lighting" for illuminated Exit signs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details for signs.
   1. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
   2. Mounting template designating stud locations is required.
   3. Provide message list, typestyles, and graphic elements including large-scale details of wording and lettering and layout for each sign.
   4. 

C. Samples for Initial Selection: Manufacturer's color charts consisting of actual units or sections of units showing the full range of colors available.

D. Samples for Verification: For each of the following products and for the full range of color, texture, and sign material indicated, of sizes indicated:
   1. Dimensional Characters: Full-size Samples of each type of dimensional character, letter, number, and graphic element required.
   2. Accessories: Manufacturer's full-size unit.
   3. Approved samples will not be returned for installation into Project.
1.4 LEED Submittals:
   A. Refer to Division 1 Section "Sustainable Design Requirements" for additional submittal requirements.
   B. Credits MR 4.1 and MR 4.2: Product Data indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.

1.5 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For Installer.

1.6 CLOSEOUT SUBMITTALS
   A. Maintenance Data: For signs to include in maintenance manuals.

1.7 QUALITY ASSURANCE
   A. Installer Qualifications: An authorized representative of signage manufacturer for installation and maintenance of units required for this Project.
   B. Source Limitations for Signs: Obtain each sign type indicated from one source from a single manufacturer.

1.8 PROJECT CONDITIONS
   A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit installation of signs in exterior locations to be performed according to manufacturers' written instructions and warranty requirements.
   B. Field Measurements: Where sizes of signs are determined by dimensions of surfaces on which they are installed, verify dimensions by field measurement before fabrication and indicate measurements on Shop Drawings.

1.9 COORDINATION
   A. Coordinate placement of anchorage devices with templates for installing signs.

1.10 WARRANTY
   A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
      1. Failures include, but are not limited to, the following:
         a. Deterioration of metal finishes beyond normal weathering.
      2. Warranty Period: Lifetime Warranty
PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Castings: ASTM B 26/B 26M, of alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated.

2.2 DIMENSIONAL CHARACTERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide Gemini Incorporated, Aluminum, 1 1/2" deep 'DEEP RIBBON' stud mount, or comparable product by one of the following:
1. ACE Sign Systems, Inc.
2. Advance Corporation; Braille-Tac Division.
4. ASI-Modulex, Inc.
5. Bunting Graphics, Inc.
6. Charleston Industries, Inc.
8. Grimco, Inc.
10. Metal Arts; Div. of L&H Mfg. Co.
15. Southwell Company (The).

C. Cast Characters: Produce characters with smooth flat faces, sharp corners, and precisely formed lines and profiles, free of pits, scale, sand holes, and other defects. Cast lugs into back of characters and tap to receive threaded mounting studs. Alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated. Comply with the following requirements.
2. Thickness: As indicated.
3. Color(s): Match Architect's samples.
   a. Color 1: Interior
   b. Color 2: Exterior
4. Character Style (Font): DEEP RIBBON (all upper case unless noted otherwise)
5. Character Height (Font):
   a. Exterior: As indicated on Drawings.
   b. Interior: As indicated on Drawings.
6. Font Spacing: as indicated on Drawings
7. Mounting: Concealed studs, non-corroding for substrates encountered.

D. Dimensional Character Sign Schedule:
1. Sign Type – Interior
   a. Sign Size: As indicated on Drawings.
   b. Character Size: As indicated on Drawings.
   c. Text/Message: To be determined by client; allow for twenty-five (25) characters at each location.
   d. Location: As indicated on Drawings.
   e. Room: Lecture Hall (022) and Lobby (F002). (Two locations total).
2. Sign Type – Exterior
2.3 ACCESSORIES

A. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.4 FABRICATION

A. General: Provide manufacturer's standard signs of configurations indicated.
   1. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in location not exposed to view after final assembly.
   2. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

2.5 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 ALUMINUM FINISHES

A. Powder-Coat Finish: Advanced Powder Coating system meeting the requirements of AAMA 2604. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying finish.
   1. Painting System: "InterponD2000" by the Kawneer Company, Inc., or an equivalent powder coated paint system meeting AAMA 2604.

B. Finishes to be applied by experienced craftsmen resulting in no surface pits or blemishes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
B. Verify that items, including anchor inserts, are sized and located to accommodate signs.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.
   1. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.

B. Dimensional Characters: Mount characters using standard fastening methods to comply with manufacturer's written instructions for character form, type of mounting, wall construction, and condition of exposure indicated. Provide heavy paper template to establish character spacing and to locate holes for fasteners.
   1. Projected Mounting: Mount characters at projection distance from wall surface; use 1” stud spacers.

3.3 CLEANING AND PROTECTION

A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Owner.

3.4 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 10 14 00
SECTION 10 21 13 - TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Solid-polymer toilet compartments configured as toilet enclosures and urinal screens.
B. Related Sections:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 06 Section "Rough Carpentry" for blocking.
   3. Division 10 Section "Toilet, Bath, and Laundry Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories.
      a. Note: toilet tissue dispensers to be provided by Owner.
C. Make sure this is true LEED Opportunities: This Section has opportunities for the following LEED points:
   1. Materials and Resources Prerequisite 1 and Credits 2.1, 4.1, 4.2 and 5.1.
   2. Indoor Environmental Quality Credit 4.1.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
B. LEED Submittals:
   1. Recycled Content Statement: Provide a statement in compliance with LEED documentation requirements, certifying percentage by weight of materials provided for project which contain:
      a. Post-consumer recycled content
      b. Post-industrial recycled content.
   2. Refer to Division 1 Section "Sustainable Design Requirements" for additional submittal requirements.
C. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachments to other work.
   1. Show locations of cutouts for compartment-mounted toilet accessories.
   2. Show locations of reinforcements for compartment-mounted grab bars.
   3. Show locations of centerlines of toilet fixtures.
   4. Show ceiling grid and overhead support or bracing locations.
D. Samples for Initial Selection: For each type of unit indicated. Include Samples of hardware and accessories involving material and color selection.

E. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
   1. Each type of material, color, and finish required for units, prepared on 6-inch- (152-mm-) square Samples of same thickness and material indicated for Work.
   2. Each type of hardware and accessory.

1.4 INFORMATIONAL SUBMITTALS
   A. Product Certificates: For each type of toilet compartment, from manufacturer.

1.5 CLOSEOUT SUBMITTALS
   A. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.6 QUALITY ASSURANCE
   B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" for toilet compartments designated as accessible.

1.7 PROJECT CONDITIONS
   A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 MATERIALS
   A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M).
   B. Stainless-Steel Castings: ASTM A 743/A 743M.

2.2 SOLID-POLYMER UNITS
   A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1. Accurate Partitions Corporation.
      2. Ampco, Inc.
5. General Partitions Mfg. Corp.
6. Global Steel Products Corp.
7. Metpar Corp.
8. Santana Products, Inc.
9. Sanymetal; a Crane Plumbing company.
10. Weis-Robart Partitions, Inc.

B. Toilet-Enclosure Style: Overhead braced, Floor anchored.

C. Urinal-Screen Style: Wall hung.

D. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material containing a minimum of 10 percent recycled material, not less than 1 inch (25 mm) thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.

1. Heat-Sink Strip: Manufacturer's standard continuous, extruded-aluminum or stainless-steel strip fastened to exposed bottom edges of solid-polymer components to prevent burning.
2. Color and Pattern: One color and pattern in each room as selected by Architect from manufacturer's full range.

E. Pilaster Shoes: Manufacturer's standard design; stainless steel.

F. Brackets (Fittings):

1. Full-Height (Continuous) Type: Manufacturer's standard design; extruded aluminum or stainless steel.

2.3 ACCESSORIES

A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.

1. Material: Clear-anodized aluminum or Stainless steel.
2. Hinges: Manufacturer’s standard self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees.
3. Latch and Keeper: Manufacturer’s standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
5. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
6. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.

B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.

C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel.
2.4 FABRICATION

A. Floor-Anchored, Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

B. Door Size and Swings: Unless otherwise indicated, provide 24-inch- (610-mm-) wide, in-swinging doors for standard toilet compartments and 36-inch- (914-mm-) wide, out-swinging doors with a minimum 32-inch- (813-mm-) wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:
   a. Pilasters and Panels: 1/2 inch (13 mm).
   b. Panels and Walls: 1 inch (25 mm).

2. Brackets: Secure panels to walls and to pilasters with continuous brackets.
   a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
   b. Align brackets at pilasters with brackets at walls.

B. Floor-Anchored, Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches (44 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.

C. Wall-Hung Urinal Screens: Attach with continuous brackets and anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.2 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

3.3 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:

   1. Aluminum
2. Plastic Materials and Gaskets
3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:

   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 10 21 13
SECTION 10 28 00 – TOILET AND SHOWER ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Public-use washroom accessories.
   2. Public-use shower room accessories.
   3. Underlavatory guards.

B. Owner-Furnished Material:
   1. Toilet Tissue Dispensers
   2. Paper Towel Dispensers
   3. Soap Dispensers
   4. Trash Receptacles

C. Related Sections:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 08 Section "Mirrors" for frameless mirrors.

D. LEED Opportunities: This Section has opportunities for the following LEED points:
   1. Materials and Resources Prerequisite 1 and Credits 2.1, 4.1, 4.2 and 5.1.
   2. Indoor Environmental Quality Credit 4.1.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include the following:
   1. Construction details and dimensions.
   2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
   3. Material and finish descriptions.
   4. Features that will be included for Project.
   5. Manufacturer's warranty.

B. Samples: Full size, for each accessory item to verify design, operation, and finish requirements.
   1. Approved full-size Samples will be returned and may be used in the Work.

C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
   1. Identify locations using room designations indicated.
   2. Identify products using designations indicated.
1.4 INFORMATIONAL SUBMITTALS
A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS
A. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

1.6 LEED Submittals:
1. Recycled Content Statement: Provide a statement in compliance with LEED documentation requirements, certifying percentage by weight of materials provided for project which contain:
   a. Post-consumer recycled content
   b. Post-industrial recycled content.
2. Refer to Division 1 Section "Sustainable Design Requirements" for additional submittal requirements.

1.7 QUALITY ASSURANCE
A. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.

1.8 COORDINATION
A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.
C. Coordinate accessory locations with related work to assure that blocking or other reinforcement is located and installed to allow for proper anchoring of all toilet accessories (including those to be provided by the Owner).

1.9 WARRANTY
A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.
B. Brass: ASTM B 19, flat products; ASTM B 16/B 16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.
C. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch minimum nominal thickness.

D. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip zinc coating.


F. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

G. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).

H. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.2 PUBLIC-USE TOILET ROOM ACCESSORIES AND ACCESSORIES ADJACENT TO TOILET/SINK IN SHOWER ROOMS

A. Basis-of-Design Product: The design for accessories is based on products indicated. Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. A & J Washroom Accessories, Inc.
   2. American Specialties, Inc.
   5. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
   6. Tubular Specialties Manufacturing, Inc.

B. Toilet Tissue Dispenser provided by Owner, blocking and installation by Contractor.

C. Paper Towel Dispenser provided by Owner, blocking and installation by Contractor.

D. Waste Receptacle provided by Owner, blocking and installation by Contractor.

E. Liquid-Soap Dispenser provided by Owner, blocking and installation by Contractor.

F. Grab Bars:
   3. Material: Stainless steel, 0.05 inch thick.
      a. Finish: Smooth, No. 4, satin finish on ends and slip-resistant texture in grip area.
   5. Configuration and Length:
      a. American Specialties, Inc. Type 01: 12 inches, Straight
      b. American Specialties, Inc. Type 02: 72 inches, Straight

G. Vendor:
   2. Type: Sanitary napkin and tampon.
   3. Mounting: Recessed. Unit to have adjustable flange to allow recessed installation in wall depths from 1” to 6”.
   4. Capacity: 27 tampons/30 feminine napkins
   5. Operation: Single coin (25 cents)
   6. Exposed Material and Finish: Stainless steel, No. 4 finish (satin)
   7. Lockset: Tumbler type with separate lock and key for coin box.
8. Locations: Provide one unit each in Women’s Toilet Room, Women’s Shower Room and each Unisex Toilet Room (8 total).

H. Sanitary-Napkin Disposal Unit:
   3. Door or Cover: Sloping cover on top with full length piano hinge.
   5. Material and Finish: Stainless steel, No. 4 finish (satin).
   6. Locations: Provide one unit for each water closet in Women’s Toilet Room, Women’s Shower Room and each Unisex Toilet Room (18 total).

I. Purse Shelf:
   1. Basis-of-Design Product: Model 0690 as manufactured by American Specialties, Inc.
   2. Description: Fixed shelf unit with raised edges.
   3. Nominal Size: 24 inches long by 6 inches wide.
   5. Locations: One unit each in Women’s Toilet Room, Women’s Shower Room and each Unisex Toilet Room (8 total).

J. Tilted Mirror Unit:
   1. Basis-of-Design Product: Bobrick, Model B-293
   2. Frame: Stainless steel, fixed tilt
      a. Corners: All edges hemmed and returned.
      b. Finish: Stainless Steel with satin finish
   3. Hangers: Produce rigid, tamper- and theft-resistant installation
   4. Size: 18 inches wide by 30 inches high.
   5. Locations: One unit each in Shower Rooms and Unisex Toilet Rooms - 126, 128, R228 and R423 (4 total).

2.3 PUBLIC-USE SHOWER ROOM ACCESSORIES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. A & J Washroom Accessories, Inc.
   2. American Specialties, Inc.
   5. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
   6. Tubular Specialties Manufacturing, Inc.

B. Shower Curtain Rod:
   1. Basis-of-Design Product: Bobrick, Model B-207
   2. Description: 18-8, type-304, 20-gauge (1.0mm) stainless steel tubing with satin finish. 1" (25mm) outside diameter.
   3. Mounting Flanges: 1-3/8" (35mm) diameter. Two Chrome-plated plastic flanges, bright polished finish, with, concealed mounting brackets (2) — aluminum.
   4. Finish: No. 4 satin.
   5. Quantity: one per shower, field verify dimensions

C. Shower Curtain Hooks:
   1. Basis-of-Design Product: Bobrick, Model 204-2
   2. Description: 18-8 S, type-304, 0.09" (2mm) diameter stainless steel.
   3. Finish: No. 4 satin.
   4. Quantity: one set per shower area
D. Shower Curtain:
1. Basis-of-Design Product: Bobrick, Model 204-2
2. Size: Minimum 12 inches wider than opening by 72 inches high.
3. Material: Vinyl, minimum 0.006 inch thick, opaque, matte.
5. Grommets: Corrosion resistant at minimum 6 inches o.c. through top hem.
6. Shower Curtain Hooks: Chrome-plated or stainless-steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.

E. Folding Shower Seat:
1. Basis-of-Design Product: Bobrick, Model B-5191
2. Configuration: Rectangular seat.
3. Seat: Phenolic or polymeric composite of slat-type or one-piece construction in color as selected by Architect.
5. Dimensions: 18" wide, 15 13/16" deep, Universal/Barrier Free recommended mounting height 17" – 19"
6. Caution: These shower seats are no stronger than the anchors and walls to which they are attached and, therefore, must be firmly secured in order to support the loads for which they are intended. Consult and comply with local building codes.

F. Soap Dish see Section 09 30 00 Tiling (accessory of wall tile).

G. Towel Pin:
2. Description: Projecting minimum of 3 inches from wall surface.
4. Quantity: Two per shower; one at ADA height (38-40"), one at standard height.

H. Grab Bars:
3. Material: Stainless steel, 0.05 inch thick.
   a. Finish: Smooth, No. 4, satin finish on ends and slip-resistant texture in grip area.
5. Configuration and Length:
   a. American Specialties, Inc. Type 01: 12 inches, Straight
   b. American Specialties, Inc. Type 02: 72 inches, Straight

2.4 UNDERLAVATORY GUARDS

A. Basis-of-Design Product: The design for accessories is based on products indicated. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
1. Plumberex Specialty Products, Inc.
2. TCI Products.
3. Truebro, Inc.

B. Underlavatory Guard:
2. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping, and allow service access without removing coverings.
3. Material and Finish: Antimicrobial, molded-plastic, color as selected by Architect from manufacturer's full range of standard and optional colors.
4. Locations: In all Toilet Rooms and at sinks in Shower Rooms, provide under lavatory guards at all lavatories.

2.5 CUSTODIAL ACCESSORIES

A. Basis-of-Design Product: The design for accessories is based on products indicated. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
   1. A & J Washroom Accessories, Inc.
   2. American Specialties, Inc.

B. Utility Shelf with utility hooks and mops strip:
   1. Basis-of-Design Product: Model 1308-4 as manufactured by American Specialties, Inc.
   2. Description: With exposed edges turned down not less than 1/2 inch and supported by two triangular brackets welded to shelf underside.
   3. Size: 44 inches long by 8 inches deep.
   4. Material and Finish: Not less than nominal 0.05-inch-thick stainless steel, No. 4 finish (satin).
   5. Mop Holder/Utility Hooks: Provide four mop hooks and five utility hooks on each unit.
   6. Locations: At all Janitor Closets, provide one unit.

2.6 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
   1. Contractor to provide concealed blocking and reinforcement at all locations to receive toilet and bath accessories.
      a. Provide for both Contractor-supplied and Owner-supplied units.
      b. Coordinate all toilet and bath accessory locations with related construction.

B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
B. Remove temporary labels and protective coatings.

C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

3.3 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 10 28 00
SECTION 10 44 13 - FIRE EXTINGUISHER CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Fire protection cabinets for the following:
   a. Portable fire extinguishers.

B. Related Sections:
1. Division 09 painting Sections for field painting fire protection cabinets.
2. Division 10 Section "Fire Extinguishers."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protection cabinets.
   1. Fire Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.

B. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.

C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
   1. Size: 6 by 6 inches square.

D. Product Schedule: For fire protection cabinets. Coordinate final fire protection cabinet schedule with fire extinguisher schedule to ensure proper fit and function.

E. Maintenance Data: For fire protection cabinets to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

1.5 COORDINATION

A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate sizes and locations of fire protection cabinets with wall depths.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

B. Stainless Steel Sheet: ASTM A 666, Type 304.

C. Glass: Clear tempered safety glass.

2.2 FIRE PROTECTION CABINET

A. Cabinet Type: Suitable for fire extinguisher.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      b. Kidde Residential and Commercial Division, Subsidiary of Kidde plc.
      c. Larsen's Manufacturing Company.
      d. Potter Roemer LLC; (Basis of Design: 7000 Series.)

B. Cabinet Construction: Nonrated and 2-hour fire rated.
   1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.0428-inch-thick, cold-rolled steel sheet lined with minimum 5/8-inch-thick, fire-barrier material. Provide factory-drilled mounting holes.

C. Cabinet Material: Steel sheet.

D. Trimless Recessed Cabinet: Cabinet box fully recessed in walls of sufficient depth and installed without trim.
   1. Trimless: One-piece combination trim and perimeter door frame flush with surrounding wall surface.
   2. Location: All recessed trimless cabinets to be located in Lecture Hall (room 022).
   3. Quantity: Two (2).

E. Semirecessed Cabinet: Cabinet box partially recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend). Provide where shown on drawings, or where walls are of insufficient depth for recessed cabinets but are of sufficient depth to accommodate semirecessed cabinet installation.
   1. Square-Edge Trim: 2 to 3-inch backbend depth.
   2. Location: Typical cabinets throughout building, U.O.N.
   3. Quantity: One unit at each location shown on the drawings U.O.N.
   4. Fire-Rating: Provide Rated Cabinets within rated wall assemblies to maintain the required fire ratings.
   5. Basis of Design Products: Model 7062 Semi-Recessed "Alta" series fire extinguisher cabinets with 2 inch square trim as manufactured by Potter Roemer for all non-rated units. Model 7063 Fire-Rated Semi-Recessed "Alta" series fire extinguisher cabinets with 3 inch square trim as manufactured by Potter Roemer for all fire-rated units.

F. Cabinet Trim Material: Stainless Steel sheet.

G. Door Material: Stainless Steel sheet.
H. Door Style: Fully glazed panel with frame.

I. Door Glazing: Safety glass.
   1. Clear tempered safety glass.

J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
   1. Provide lock with Break Rite handle.
   2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.

K. Finishes:
   1. Manufacturer's standard baked-enamel paint for the following:
      a. Interior of cabinet.
   2. Stainless Steel: Manufacturer’s standard:
      a. Exterior trim and cabinet door.

2.3 FABRICATION

A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
   1. Weld joints and grind smooth.
   2. Provide factory-drilled mounting holes.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
   1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
   2. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.4 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM’s "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 STEEL FINISHES

A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.

B. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting
topcoat. Comply with coating manufacturer’s written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

1. Color and Gloss: As selected by Architect from manufacturer’s full range of colors and finishes.

2.6 STAINLESS STEEL FINISHES

A. General: Remove tool and die marks and stretch lines or blend into finish.

1. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

B. Provide type 304 stainless steel with #4, bright directional finish.

C. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets will be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recesses for trimless recessed and semirecessed fire protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

B. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.

1. Fasten mounting brackets to inside surface of fire protection cabinets, square and plumb.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.
E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

3.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 10 44 13
SECTION 10 44 16 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes portable fire extinguishers and mounting brackets for fire extinguishers.

B. Related Sections:
   1. Division 10 Section "Fire Extinguisher Cabinets."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

B. Product Schedule: For fire extinguishers. Coordinate final fire extinguisher schedule with fire protection cabinet schedule to ensure proper fit and function.

C. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

D. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
   1. Provide fire extinguishers approved, listed, and labeled by FMG.

1.5 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure of hydrostatic test according to NFPA 10.
      b. Faulty operation of valves or release levers.
   2. Warranty Period: Six years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and mounting bracket indicated.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
      c. Larsen's Manufacturing Company.
      d. Potter Roemer LLC.

2. Valves: Manufacturer's standard.
3. Handles and Levers: Manufacturer's standard.
4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.2 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
   1. In all Mechanical Rooms, surface mount fire extinguisher to wall with manufacturer's standard bracket.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

3.3 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 10 44 16
SECTION 10 51 13 - METAL LOCKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

B. Related Section:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.

1.3 LEED Opportunities: This Section has opportunities for the following LEED points:

1. Materials and Resources Prerequisite 1 and Credits 2.1, 4.1, 4.2 and 5.1.
2. Indoor Environmental Quality Credit 4.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker.

B. Shop Drawings: For metal lockers. Include plans, elevations, sections, details, and attachments to other work.
   1. Show locker trim and accessories.
   2. Include locker identification system and numbering sequence.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For metal lockers, in manufacturer's standard sizes.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Warranty: Sample of special warranty.
1.6 CLOSEOUT SUBMITTALS
A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Full-size units of the following metal locker hardware items equal to 10 percent of amount installed for each type and finish installed, but no fewer than five units:
   a. Locks.
   b. Identification plates.
   c. Hooks.

1.8 QUALITY ASSURANCE
A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain metal lockers and accessories from single source from single manufacturer.

C. Regulatory Requirements: Where metal lockers are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities".

D. Preinstallation Conference: Conduct conference at Project site.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for their installation.

B. Deliver combination control charts to Owner directly at the Pennsylvania State University Office of Physical Plant, addressed as follows:

1. Director of Buildings and Grounds, The Pennsylvania State University, Office of Physical Plant, 125 Physical Plant Building, University Park, Pa 16802.

1.10 PROJECT CONDITIONS
A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.
1.11 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures.
   b. Faulty operation of latches and other door hardware.

2. Damage from deliberate destruction and vandalism is excluded.
3. Warranty Period for All-Welded Metal Lockers: Lifetime from date of Substantial Completion. At project closeout, provide to Owner or Owners Representative an executed copy of the manufacturer's standard limited warranty against manufacturing defect, outlining its terms, conditions, and exclusions from coverage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with A60 (ZF180) zinc-iron, alloy (galvannealed) coating designation.

2.2 HEAVY-DUTY METAL LOCKERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide American Locker Security Systems, 'Envoy' Employee Lockers, or approved equal.

B. Locker Arrangement: Single tier.

C. Material: Cold-rolled steel sheet.

D. Dimensions: 72" Frame height, 15" Frame width, 18" Frame depth.

E. Body: Assembled by welding body components together; welded hasp assembly. Fabricate from un-perforated steel sheet with thicknesses as follows:

1. Locker Frame: Minimum 16 gauge nominal thickness.
2. Locker Sloping Tops: Minimum 20 gauge nominal thickness.
3. Locker Bottom Shelf and Recessed Base: Galvanized Steel, minimum 20 gauge nominal thickness.
4. Locker Sides: Minimum 24 gauge nominal thickness.
5. Locker Backs: Minimum 24 gauge nominal thickness.
7. Locker Shelves: Minimum 22 gauge nominal thickness, with double bend at front and single bend at sides and back.
8. Locker Hinges: Minimum 14 gauge nominal thickness.
10. Locker Handles: Minimum 18 gauge nominal thickness.

F. Frames: Channel formed; fabricated from Minimum 16 gauge nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral door strike full height on vertical main frames.

G. Doors: One piece; fabricated from Minimum 20 gauge nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.
   1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches (381 mm) wide; welded to inner face of doors.
   2. Door Style:
      a. Perforated Vents: Manufacturer's standard shape and configuration.

H. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.
   1. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum 2 inches (51 mm) high. Provide no fewer than three hinges for each door more than 42 inches (1067 mm) high.
   2. Continuous Hinges: Manufacturer's standard, steel, full height.

I. Recessed Door Handle and Latch: Stainless-steel cup with integral door pull, recessed so locking device does not protrude beyond face of door; pry and vandal resistant.
   1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks or padlocks; positive automatic latching and pre-locking.
      a. Latch Hooks: Equip doors 48 inches (1219 mm) and higher with three latch hooks; fabricated from 0.120-inch (3.04-mm) nominal-thickness steel sheet; welded to full-height door strikes; with resilient silencer on each latch hook.
      b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a pre-locking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

J. Built-in Combination Locks: Key-controlled, three-number dialing combination locks; capable of at least five combination changes made automatically with a control key.

K. Equipment: Equip each metal locker with identification plate and the following unless otherwise indicated:
   1. Single-Tier Units: Shelf, one double-prong ceiling hook, and two single-prong wall hooks.

L. Accessories:
   1. Continuous Zee Base: Fabricated from, manufacturer's standard thickness, but not less than Minimum 20 gauge nominal-thickness steel sheet.
      a. Height: 4 inches (102 mm).
2. Continuous Sloping Tops: Fabricated from Minimum 20 gauge nominal-thickness steel sheet, with a pitch of approximately 20 degrees.
   a. Closures: Vertical-end type.
M. Finish: Baked enamel.
   1. Color(s): As selected by Architect from manufacturer's full range.

2.3 FABRICATION

A. Fabricate metal lockers square, rigid, and without warp and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.
   1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
   2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.
B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments. Factory weld frame members of each metal locker together to form a rigid, one-piece assembly.
C. All-Welded Construction: Factory preassemble metal lockers by welding all joints, seams, and connections; with no bolts, nuts, screws, or rivets used in assembly of main locker groups. Factory weld main locker groups into one-piece structures. Grind exposed welds flush.
D. Accessible Lockers: Fabricate as follows:
   1. Locate bottom shelf no lower than 15 inches (381 mm) above the floor.
   2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches (1219 mm) above the floor.
E. Hooks: Manufacturer's standard ball-pointed type, aluminum or steel; zinc plated.
F. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch (9 mm) high.
G. Continuous Base: Formed into channel or zee profile for stiffness, and fabricated in lengths as long as practical to enclose base and base ends of metal lockers; finished to match lockers.
H. Continuous Sloping Tops: Fabricated in lengths as long as practical, without visible fasteners at splice locations; finished to match lockers.
I. Recess Trim: Fabricated with minimum 2-1/2-inch (64-mm) face width and in lengths as long as practical; finished to match lockers.
J. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.
K. Boxed End Panels: Fabricated with 1-inch-(25-mm-) wide edge dimension, and designed for concealing fasteners and holes at exposed ends of non-recessed metal lockers; finished to match lockers.

1. Provide one-piece panels for double-row (back-to-back) locker ends.

L. Finished End Panels: Designed for concealing unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of non-recessed metal lockers; finished to match lockers.

1. Provide one-piece panels for double-row (back-to-back) locker ends.

2.4 STEEL SHEET FINISHES

A. Factory finish steel surfaces and accessories except stainless-steel and chrome-plated surfaces.

B. Baked-Enamel Finish: Immediately after cleaning, pretreating, and phosphatizing, apply manufacturer's standard thermosetting baked-enamel finish. Comply with paint manufacturer's written instructions for application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install level, plumb, and true; shim as required, using concealed shims.

1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches (910 mm) o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.

2. Anchor metal lockers to walls at spacing indicated on approved shop drawings with appropriate anchor devices to suit adjacent materials and finishes.

B. All-Welded Metal Lockers: Connect groups together with standard fasteners, with no exposed fasteners on face frames.

C. Equipment and Accessories: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.

1. Attach hooks with at least two fasteners.

2. Attach door locks on doors using security-type fasteners.

3. Identification Plates: Identify metal lockers with identification indicated on Drawings.

   a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
4. Attach recess trim to recessed metal lockers with concealed clips.
5. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
6. Attach sloping-top units to metal lockers, with closures at exposed ends.
7. Attach boxed end panels with concealed fasteners to conceal exposed ends of non-recessed or semi-recessed metal lockers.
8. Attach finished end panels with fasteners only at perimeter to conceal exposed ends of non-recessed or semi-recessed metal lockers.

3.3 ADJUSTING, CLEANING, AND PROTECTION

A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding. If required, verify that integral locking devices operate properly.

B. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.

C. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

3.4 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 10 51 13
SECTION 11 01 14 – FALL RESTRAINT EQUIPMENT

PART 1: GENERAL

1.1 SUMMARY SECTION INCLUDES

A. Horizontal fall restraint cable system including
   1. System design
   2. Cable
   3. Intermediate anchors
   4. Terminating anchors
   5. Energy absorber

1.2 Related Sections

A. Section 03300 Cast-In-Place Concrete
B. Section 05120 Structural Steel
C. Section 05500 Metal Fabrications
D. Section 07500 Membrane Roofing
E. Section 07620 Sheet Metal Flashing and Trim
F. Section 07920 Joint Sealants

1.3 REFERENCES

A. Publications listed herein are part of this specification to extent referenced.
   1. American Institute of Steel Construction (AISC)
      a. AISC Publication Load and Resistance Factor Design for Structural Steel Buildings
      b. AISC Specifications for the Design of Cold-Formed Steel Structural Members
      a. ASTM A36 Specification for Structural Steel
      b. ASTM A123 Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Hardware
      c. ASTM A500 Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
      d. ASTM A780 Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
      e. ASTM B209-04 Specification for Aluminum and Aluminum-Alloy Sheet and Plate
      f. ASTM B221-02 Specification for Aluminum and Aluminum-Alloy Extruded Bars, Wire, Shapes, and Tubes
      g. ASTM B308/B308M-02 Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
   3. American Welding Society (AWS)
      a. AWS D1.1 Structural Welding Code
   4. Occupational Safety and Health Standards
      a. 1910.66 Appendix C (Personal Fall Arrest)

1.4 SYSTEM DESCRIPTION

A. Anchorage Design Requirements
1. Safety anchor system design shall comply with current OSHA, ANSI, and local regulations pertaining to fall protection in accordance with sections 1.1, 1.2, and 1.3.
2. Anchor system shall provide independent fall arrest anchorages as required by OSHA and ANSI requirements.
3. Structural design requirements of anchorages and tie-back
   a. Anchorage shall be capable of sustaining a minimum ultimate load of 5,000 lbs., in any direction the load may be applied, without fracture or failure.
   b. Anchorage shall be capable of sustaining a minimum proof load of 2,500 lbs., in any direction the load may be applied, without permanent deformation or damage to anchorage.
   c. Anchorages shall be designed with a minimum 1,250 lb. working load, in any direction the load may be applied.

B. Horizontal fall restraint cable system
1. The Horizontal fall restraint cable system (HFRCS) shall allow up to two users to traverse the length of the cable span, each using a single lanyard for traveling along the cable spans. Turns in the HFRCS will require a double lanyard. The HFRCS shall be designed for two users using an energy absorbing lanyard, which limits the force applied to the HFRCS to 900 lb. or less.
2. HFRCS shall spans shall not exceed 100 foot long.
3. The horizontal line shall be constructed of 3/8” x 7 x 19 stainless steel or galvanized aircraft cable, commercial grade per specification SD 118 and Fed. Spec. RR-W-410, construction grade, with an average breaking strength of not less than 14,400 lbs.
4. Horizontal lines shall be permanently attached to anchors with 2 non-corrosive permanently swaged fittings swaged to manufacturer's specifications at each termination. Swages shall be verified not to loosen under load. Load capacity of one swage shall exceed strength of wire rope.
5. Horizontal lines must be attached to anchorages designed to be capable of supporting a minimum 5,000 lb. However, the HFRCS cable and anchorages shall be independent of anchorages used for suspension in accordance with Section 1.4(A) Anchorage Design Requirements.

1.5 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product proposed
   1. Test report certified by a professional engineer
   2. General product data
   3. Detailed drawings of equipment proposed
   4. Installation instructions

B. Shop Drawings
   1. Submit scaled shop drawings showing location plan of all fall restraint equipment and sections detailing all parts and accessories.
   2. Clearly specify equipment dimensions, materials, fabrication details, hardware, and installation instructions.
   3. Include notes with guidelines of proper use of system.
   4. Equipment location plan to include identification number next to each piece of fall restraint equipment (anchors, etc.) that are permanently affixed to a structure.
   5. Field welds shall be indicated on equipment details using AWS symbols and showing length and size. Auxiliary views shall be shown to clarify welding as required.
   6. Shop drawings shall be prepared under supervision of a registered professional engineer and shall bear engineer’s seal and signature. Professional engineer shall be licensed in jurisdiction where project is located. Include P.E. certified report of tested equipment.

C. Quality Assurance Submittal Certificates
   1. Provide documentation verifying company’s amount of experience and successful performance in design, fabrication, and installation of permanent fall restraint equipment.
2. Submit listing of company’s installations representing similar scope and complexity to project requirements for previous 10 years. List shall include information as follows:
   a. Project name and address
   b. Name of owner
   c. Name of contractor
   d. Name of architect (if applicable)
   e. Date of completion
3. Provide documentation verifying that installers have been trained by the manufacturer and are competent.

D. Contract Close-out Submittals
   1. Operation and Maintenance
      a. Provide a safety inspection logbook for yearly inspections. Log book shall include a certification of compliance letter. The certification of compliance shall state that access system is in compliance with current OSHA regulations.
   2. Project Record Document Data
      a. Record anchor locations and details.
      b. Submit 2 copies of a reduced, plastic laminated Project Record Drawing showing as-installed anchor locations, details, and instructional text in English (and Spanish upon request). Post one copy on interior of each roof door or adjacent to exit on roof; owner shall establish exact location.
      c. Submit a letter of certification by a registered professional engineer licensed in jurisdiction where project is located verifying that installed anchors and system are in compliance with OSHA and ANSI requirements as specified. Each piece of access equipment dedicated to the building shall be tested on site under the supervision of a P.E. in accordance with manufacturer’s/provider’s test procedures.

1.6 QUALITY ASSURANCE

A. Qualifications
   1. Provide products from a company specializing in design, fabrication, and installation of permanent fall restraint equipment with a minimum of 5 years documented experience. Companies like miscellaneous metal fabricators not normally engaged in design and fabrications of fall restraint equipment are not acceptable.
   2. Manufacturer and installer shall have specific liability insurance (products and completed operations) in an amount not less than $5,000,000.
   3. Installer(s) shall be trained or qualified by manufacturer in installation techniques and procedures of fall restraint equipment and shall demonstrate a minimum of 5 years successful experience in such installation.

B. Regulatory Requirements
   1. Comply with Occupational Health and Safety Standards:
      a. 1910.66 Appendix C (Personal Fall Arrest)
   2. Welding shall comply with AWS D1.1 and shall be performed by welders qualified to work in jurisdiction where project is located.
   3. Comply with AISC publications:
      a. Load and Resistance Factor Design for Structural Steel Buildings
      b. Specifications for the Design of Cold-Formed Steel Structural Members

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original unopened packaging.

B. Storage and Protection
   1. Store materials in a protected area away from construction activities.
   2. Clean bolts that have become dirty before installing.
3. Special care must be taken with stainless steel since not compatible with many chemicals and materials.
4. Do not install damaged materials. Remove damaged materials from site.

1.8 SEQUENCING AND COORDINATION

A. General contractor is responsible for coordinating the schedule for producing shop drawings, fabricating suspended access equipment, and installation. General contractor shall allow three weeks for delivery of shop drawings and three weeks to deliver equipment upon approval of shop drawing by general contractor.

B. Manufacturer to provide detailed installation instructions and directions for installation of embedded items, welded items, and through-bolted items, etc.

C. Manufacturer to provide installation assistance during installation of the equipment. However, the responsibility of the installation rests with the general contractor unless equipment is installed and certified by the manufacturer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS & Installers

A. Basis-of-Design: Subject to compliance with requirements, provide listed Fall Restraint System, or approved equal:
   1. Summit Anchor Company
      Tel: 800-372-1098
      Fax: 301-620-9819
      Web Site: www.summitanchor.com

2.2 STRUCTURAL COMPONENTS' MATERIALS

A. Exposed Structural Components Finish: Galvanized Mild Steel or Stainless Steel
   1. Steel: ASTM A572 GR 50
   2. Steel: ASTM A36
   3. Galvanizing: ASTM A123
   4. Stainless Steel; 304 ASTM A 193 Grade B8, Class 2
   5. Aluminum; 6061-T6 Alloy

B. Yield Strength
   1. Base Plates and Bottom Plates, High Strength Steel: 50 ksi minimum
   2. Other Sections: 36 ksi minimum

C. Non-Structural Components
   1. Aluminum; 6061-T6 Alloy
   2. Alloys shall conform to requirements published in AA Aluminum Standards.
   3. Sheet and Plate: ASTM B209
   4. Extruded Bars, Rods, Shapes, and Tubes: ASTM B221

D. Cold-Rolled Sections
   1. ASTM A500
   2. Yield Strength: 55 ksi minimum
   3. Tensile Strength: 62 ksi minimum

E. Nuts, Bolts, Davit Pins, and Washers
   1. Stainless Steel; 304 ASTM A 193 Grade B8 or F593C
2. Galvanized Flat Washers ASTM F-436 or 18-8 Stainless Steel

F. Anchor Bolts (for securing base plate)
1. Metal: Stainless Steel, 304 Stainless Steel; ASTM A 193 Grade 8, B8
2. Size: 5/8 in. diameter minimum

G. Hilti HDA Undercut Anchoring System
1. HAD-T Undercut Anchor (Through-Set Type)
2. Anchor size and embedment depth: As needed to suit loads imposed by equipment. Consult project engineer to determine proper anchoring system based on concrete condition, psi, and thickness before ordering equipment.
3. Installed per Hilti installation instructions.

H. Hilti HVA Capsule Adhesive Anchoring System
1. Anchor size and embedment depth: As needed to suit loads imposed by equipment. Consult project engineer to determine proper anchoring system based on concrete condition, psi, and thickness before ordering equipment.
2. Installed per Hilti installation instructions.
3. Installed by Hilti accredited installers only.
4. Each installed anchor assembly shall be load tested to 50 percent of its rated capacity. Test results shall be certified a P.E. with experience in suspended access equipment.

2.3 MANUFACTURED UNITS

A. Anchor
1. Capable of withstanding 5000 lbs. (2268kg) in any direction without permanent deflection.
2. Anchor eye size: Not less than ¾ inch (20 mm) diameter material with 2 ¼ in (60 mm) eye opening.
3. Anchor eye metals:
4. Forged, 1030 quenched and tempered per ASTM 576-90-b, 72ksi minimum
5. Stainless steel, type 304, solution annealed, 35 ksi minimum
6. 
7. Anchor tube height: not less than 4 in. above the finished roof.

B. Cable system
1. Install complete with inline shock absorber to limit load to 2,250 lbs. or less at terminating anchors.
2. Pass through cable anchors to allow up to two workers to traverse straight cable runs with single lanyard without detachment off lanyard.

C. Flashing with one E.P.D.M. gasket seal top and base
1. Seamless Spun Aluminum Flashing: ASTM B221; Type 6061-T6 alloy
2. Stainless Steel: 304

D. Cast in place equipment
1. A minimum of two cast-in-place steel studs are required for concrete embedded anchors.

2.4 FABRICATION

A. Fabricate work true to dimension, square, plumb, level, and free from distortion or defects detrimental to appearance and performance.

B. Grind off surplus welding material to ensure exposed surfaces are smooth so as not to abrade workers’ ropes.

C. Welding shall be in accordance with the AWS Structural Welding Code D1.1/D1.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions
1. Examine areas and conditions under which permanent fall restraint equipment shall be installed.
2. Report to general contractor any conditions that deviate from shop drawings or any defects in workmanship that would cause an unsafe installation. This report shall be verified in writing to the general contractor and any other responsible party.
3. Correct conditions detrimental to timely and proper execution of work.
4. Do not proceed until unsatisfactory conditions have been corrected.
5. Commencement of installation constitutes acceptance of conditions and responsibility for satisfactory performance by installer.
6. Faults occurring in work of this section due to acceptance of unsatisfactory conditions shall be corrected at no additional cost to owner.

3.2 INSTALLATION

A. General Requirements
1. Install fall restraint system in compliance with manufacturer’s instructions. Install equipment level, tightly fitted, and flush to adjacent surfaces as needed for proper installation.
2. Coordinate anchor installation with roofing installation to ensure a watertight and warrantable condition of the roofing. Anchors shall be directly flashed into roofing in a manner compatible with roofing system and anchors.
3. When components come into contact with dissimilar metals, surfaces shall be kept from direct contact to prevent corrosion.
4. No wall anchors shall be installed through membrane roofing system without specification detailing such from the architect or waterproofing company warranting the roof.
5. Deform a minimum of two threads of tail end of anchor studs after nuts have been tightened to prevent accidental removal or vandalism. Deform threads with 2/32" stainless steel punch.

B. Instructions for welding access equipment to structure
1. All welders must be certified to American Welding Society (AWS) in accordance with AWS standards.
2. Welding rods used to weld the anchor system to be E70 xx electrodes.
3. Prior to welding anchors to structure, abrasively remove within one inch of all welded surfaces galvanizing, mill, scale, and rust.
4. Immediately after welding, chip away slag to prepare for welding inspector to inspect welds.
5. An AWS certified welding inspector must inspect and confirm size of all field welds. Following the inspection a written report must be supplied to the building owner and/or general contractor. Welded joints shall not be painted until after welding has been completed and the weld accepted.
6. Immediately after an acceptable inspection, paint welded areas with cold-galvanizing compound to protect from corrosion.
7. Structural steel to receive roof or wall anchors shall have a surface wide enough so that base plate can be welded all the way around. For example, anchors equipped with 4½ in. (112.5 mm) base plates would require a minimum 5 in. (137.5 mm) surface to weld to.

C. Adhesive and Undercut Anchor Fasteners
1. Installation of Summit Anchor Co. equipment mounted with adhesive type anchor fasteners shall be performed by Hilti accredited installers only.
2. Installation of Summit Anchor Co. equipment mounted with undercut type anchor fasteners shall be performed by Hilti trained installers only.

D. Aluminum Flashing
1. Deck flange shall be flashed in compliance with National Roofing Contractor Association recommendations.

3.3 REPAIR/RESTORATION

A. Galvanizing Touch-Up
   1. Immediately after erection clean field welds and abraded areas. Repair damaged areas in compliance with ASTM A780.

3.4 FIELD QUALITY CONTROL

A. Inspection and site visits
   1. Inspections and site visits shall be performed while installation of equipment is in progress under the supervision qualified professional engineer registered in the jurisdiction where the project is located.
   2. On site inspection of equipment welded to structure shall be performed by an AWS Certified Welding Inspector verifying, in writing, size and quality of welds. Such an inspection shall be performed on each piece of equipment before roofing material is installed.
   3. On site inspection shall be performed on all cast in place items while being tied in with the rebar with sufficient time before concrete is poured to allow to adjustments to embedded items as recommended by inspector.
   4. G.C. shall be responsible to schedule above site visits and inspections with sufficient advanced notice given to the inspection company.

B. Site Tests
   1. All equipment shall be tested on site in accordance with manufacturer’s recommendations, under the supervision of a professional engineer before being placed in service.
   2. Equipment shall be tested under the supervision of a professional engineer with experience with fall restraint equipment and manufacturers guidelines.

C. Manufacturer shall assist and/or supervise installation of fall restraint equipment installed by others when such is included in contracted.

3.5 ADJUSTING

A. Verify that completed work has been installed correctly and products function properly. Make adjustments where needed to ensure satisfactory operation.

B. Complete inspection logbook to certify system for use noting any deviations, changes, or corrections from original shop drawings. Provide as-built anchor layout plan on 11 in. x 17 in. paper or larger together with annual inspection log book.

END OF SECTION  11 01 14
SECTION 11 52 13 - PROJECTION SCREENS & PROJ MOUNTS [C]

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Electrically operated projection screens and controls.
   2. Projector mount and vibration isolation plate.
B. Related Sections:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.
   2. Division 05 Section "Metal Fabrications" for metal support framing for projection screens.
   3. Division 06 Section "Rough Carpentry" for wood backing for screen installation.
   4. Division 09 Section “Painting” for special Projection Wall Finish in Lecture Hall.
   5. Division 26 Sections for electrical service and connections including device boxes for switches and conduit, where required, for low-voltage control wiring.
C. LEED Opportunities: This Section has opportunities for the following LEED points:
   1. Materials and Resources Prerequisite 1 and Credits 2.1, 4.1, 4.2 and 5.1.
   2. Indoor Environmental Quality Credit 4.1.

1.3 DEFINITIONS
A. Gain of Front-Projection Screens: Ratio of light reflected from screen material to that reflected perpendicularly from a magnesium carbonate surface as determined per SMPTE RP 94.
B. Half-Gain Angle: The angle, measured from the axis of the screen surface to the most central position on a perpendicular plane through the horizontal centerline of the screen where the gain is half of the peak gain.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: For projection screens. Show layouts and types of projection screens. Include the following:
   1. For electrically operated projection screens and controls:
      a. Location of screen centerline relative to ends of screen case.
      b. Location of wiring connections for electrically operated units.
      c. Location of seams in viewing surfaces.
      d. Drop lengths.
      e. Anchorage details, including connection to supporting structure for suspended units.
      f. Details of juncture of exposed surfaces with adjacent finishes.
      g. Accessories.
      h. Wiring diagrams.
C. Samples for Initial Selection: For finishes of surface-mounted screen cases.

1.5 CLOSEOUT SUBMITTALS
A. Maintenance Data: For projection screens to include in maintenance manuals.

1.6 LEED Submittals
A. Refer to Division 1 Section "LEED Requirements" for additional submittal requirements.
B. Credits MR 4.1 and MR 4.2: Product Data indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
   1. Include statement indicating costs for each product having recycled content.

1.7 QUALITY ASSURANCE
A. Source Limitations for Projection Screens: Obtain each type of projection screen from single manufacturer. Obtain accessories, including necessary mounting hardware, from screen manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Environmental Limitations: Do not deliver or install projection screens until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
B. Always handle screen in horizontal position.
C. Do not unpack screen or remove outer wrapping from case, or, remove black tape or bands from slat pocket until installation.

1.9 COORDINATION
A. Coordinate layout and installation of projection screens with adjacent construction, including ceiling suspension systems, light fixtures, HVAC equipment, fire-suppression system, and partitions. See Drawings for plan dimensions and angle of screen installation.

PART 2 - PRODUCTS

2.1 ELECTRICALLY OPERATED PROJECTION SCREENS
A. General: Manufacturer's standard units consisting of case, screen, motor, controls, mounting accessories, and other components necessary for a complete installation. Provide units that are listed and labeled as an assembly by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
1. Controls: Remote, three-position control switch installed in recessed device box with flush cover plate matching other electrical device cover plates in room where switch is installed. Provide engraved: SCREEN UP, STOP, DOWN on switch plate to operate screen movement.
   a. Provide one control switch for each screen.
   b. Provide power supply for low-voltage systems if required.
   c. Provide locking cover plates for switches.
2. Motor in Roller: Instant-reversing motor of size and capacity recommended by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Mount motor inside roller with vibration isolators to reduce noise transmission.
3. Screen Mounting: Top edge securely anchored to rigid metal roller and bottom edge formed into a pocket holding a 3/8-inch- diameter metal rod with ends of rod protected by plastic caps.
   a. Roller for motor in roller supported by vibration- and noise-absorbing supports.

B. Suspended, Electrically Operated Screens for recessed ceiling installation: Motor-in-roller units designed and fabricated for suspended mounting concealed above finished ceilings; bottom of unit with open slot to allow screen to lower and raise freely. [C]
1. Basis of Design Product: Subject to compliance with requirements, provide the following, or equal:
   a. Motor in Roller:  
      1) Da-Lite Screen Company; Cosmopolitan Electrol.
2. Provide metal or metal-lined wiring compartment on units with motor in roller.
3. Ceiling Trim Kit: Provide manufacturer's standard trim kit for installation of electrically operated screen units above finished ceilings. Trim kit shall provide 1.84 inch slot in finished ceiling for screen. If low voltage controls are incorporated into the screens, supply with built-in low voltage control. [C]
4. Screen Case: Made from metal and fire-retardant materials.
5. Provide screen case with trim flange to receive ceiling finish.
6. Finish on Exposed Surfaces: Prime painted or baked enamel.

2.2 FRONT-PROJECTION SCREEN MATERIAL
A. Matte-White Viewing Surface: Peak gain not less than 0.9, and gain not less than 0.8 at an angle of 50 degrees from the axis of the screen surface.
1. Basis of Design Product: Subject to compliance with requirements, provide one of the following, or equal:
   a. Da-Lite Screen Company; Matte White.
C. Mildew-Resistance Rating: 0 or 1 when tested according to ASTM G 21.
D. Flame Resistance: Passes NFPA 701.
E. Flame-Spread Index: Not greater than 75 when tested according to ASTM E 84.
F. Seamless Construction: Provide screens, in sizes indicated, without seams.
G. Edge Treatment: Without black masking borders.
H. Size of Viewing Surface: 
   1. Electrically Operated Projection Screens:
      a. Type 1:  43 by 57 inches.
      b. Type 2:  60 by 80 inches.
c. Type 3: 10 by 10 feet.
d. See Drawings for location of each type.

I. Accessories: For recessed ceiling mounted units provide mounting brackets, threaded rod supports, and all other required accessories required to provide a complete installation.

2.3 PROJECTOR MOUNT AND VIBRATION ISOLATION PLATE

A. Projector Mount: Provide adjustable projector mount and all necessary accessories for each projector listed.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Da-Lite UPM-1 Advance Universal Projector Mount.
      b. Roll adjustment of +/- 20 degrees; Pitch adjustment of +/- 15 degrees; 360 degree swivel.
      c. Supports projectors up to 50 pounds.
      d. Powder coat finish, color to be selected by Architect from manufacturer's full line of standard and premium colors.
      e. CM-P: NPT pipe for connecting ceiling mount coupling plate and mount. Provide lengths as required for each application so that projector hangs correct distance below ceiling.
      f. NOTE: Projectors by Owner.

B. Isolation Plate: Provide adjustable projector mount and all necessary accessories for each projector listed.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Da-Lite CM-VIP Vibration Isolation Ceiling Plate.

C. Locations: Provide Projector Mounts, Isolation Plates and Pipe Connectors for each projector in the following rooms:
   1. Classroom 102
   2. Classroom 102a
   3. Lecture Hall 022

2.4 FRONT-PROJECTION SCREEN INSTALLATION

A. Install front-projection screens at locations indicated to comply with screen manufacturer's written instructions.

B. Provide blocking, threaded rods and all other required supports to provide for concealed support of recessed ceiling screen. Provide blocking within walls at all wall-mounted screens. Coordinate with all adjacent construction and finishes. FROM PSU WB

C. Install front-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.
   1. Install low-voltage controls according to NFPA 70 and complying with manufacturer's written instructions.
      a. Wiring Method: Install wiring in raceway except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
   2. Test electrically operated units to verify that screen controls, limit switches, closures, and other operating components are in optimum functioning condition.
   3. Test manually operated units to verify that screen-operating components are in optimum functioning condition.
   4. Confirm that screen installation is level and plumb.
2.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 11 52 13
SECTION 12 24 13 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Manually operated sunscreen roller shades with single rollers. Type 1.
   3. Accessories.
   4. Local group and master control system for shade operation with encoded motors and addressable system.

B. Related Requirements:
   1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements
   2. Division 06 Section "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
   3. Division 09 Section "Gypsum board Assemblies" for coordination with gypsum board assemblies for installation of closures and related accessories.
   4. Division 26 Sections for electrical service and connections for motors, controls, limit switches, and other powered devices and for system disconnect switches for motor-operated shades.
   5. Roller Shade dealer/installer will bid:
      a. Roller shade hardware, shade fabric, and motor furnished and installed as a complete assembly.
      b. All electrical and electronic controls and accessories required for a complete control system including appropriate interface to communicate with stand alone BMS, daylighting, AV, or Central Integration contractor, shall be provided as part of the roller shade dealer / installer based proposal as a separate line item listing the control / interface components provided. Equipment shall include, but not be limited to, motor controllers, dry contact closures, RS-232, or 485 interface units, transformers, relays, and/or interface units as required.
      c. Roller shade dealer / installer shall list all components included in their bid and shall be financially responsible for any change orders and / or back charges required by the BMS, AV, or lighting control system contractors to interface with the motorized roller shade system.

C. LEED Opportunities: This Section has opportunities for the following LEED points:
   1. Materials and Resources Prerequisite 1 and Credits 2.1, 4.1, 4.2 and 5.1.
1.3 REFERENCES

B. NFPA 70 - National Electrical Code.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Manufacturers Data sheets to include:
      a. preparation instructions and recommendations.
      b. styles, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
      c. construction/mounting details and installation methods
      d. Storage and handling requirements and recommendations.
      e. Typical wiring diagrams including integration of motor controllers with building management system, audiovisual and lighting control systems as applicable.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations. Show location and extent of roller shades. Include plans, elevations, sections, product details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other work, operational clearances, and relationship to adjoining work.
   1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Ceiling suspension system members and attachment to building structure.
   2. Ceiling-mounted or penetrating items including light fixtures, air outlets and inlets, speakers, sprinklers, recessed shades, and special moldings at walls, column penetrations, and other junctures of acoustical ceilings with adjoining construction.
   3. Shade mounting assembly and attachment.
   4. Size and location of access to shade operator, and adjustable components.
   5. Minimum Drawing Scale: 1/8 inch = 1 foot.

D. Samples for Initial Selection: For each finish product specified, one set of shade cloth options and aluminum finish color samples representing manufacturer’s full range of available colors and patterns.
   1. Include Samples of accessories involving color selection.

E. Samples for Verification: For each type of roller shade finish product specified
   1. Shadeband Material: Not less than 10 inches square from dye lot used for the Work, with specified treatments applied. Show complete pattern repeat. Mark face of material to indicate interior faces.
2. Roller Shade: Full-size operating unit, not less than 16 inches wide by 36 inches long for each type of roller shade indicated.
3. One set of shade components, unassembled, demonstrating compliance with specified requirements.
4. Installation Accessories: Full-size unit, not less than 10 inches long.

F. Roller-Shade Schedule: Use same room designations indicated on Drawings and include opening sizes and key to typical mounting details.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.
B. Product Certificates: For each type of shadeband material, signed by product manufacturer.
C. Product Test Reports: For each type of shadeband material, for tests performed by a qualified testing agency.
G. LEED Submittals:
   1. Credits MR 4.1 and MR 4.2: Product Data indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
      a. Include statement indicating costs for each product having recycled content.
   2. Refer to Division 1 Section "Sustainable Design Requirements" for additional submittal requirements.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roller shades to include in maintenance manuals.
   1. Methods for maintaining roller shades and finishes.
   2. Precautions regarding cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.
   3. Instructions for operating hardware and controls.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than ten units.
1.8 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products; Installer trained and certified by the manufacturer with a minimum of ten years experience in installing products comparable to those specified in this section.

B. Anti-Microbial Characteristics: ‘No Growth’ per ASTM G21 results for fungi ATCC9642, ATCC 9644, and ATCC9645.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution. Locate mock-up in window designated by Architect.

1. Do not proceed with remaining work until, mock-up is accepted by Architect.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in factory packages, marked with manufacturer and product name, fire-test-response characteristics, lead-free designation, and location of installation using same room designations indicated on Drawings and in a window treatment schedule.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.11 WARRANTY

A. Roller Shade Hardware, Chain and Shadecloth: provide Manufacturer’s standard non-depreciating twenty-five year warranty commencing on date of Substantial Completion.

B. Roller Shade Motors and Motor Control Systems: provide Manufacturer’s standard non-depreciating five year warranty commencing on date of Substantial Completion.

C. Roller Shade Installation: provide one year warranty commencing on date of Substantial Completion.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide MechoShade systems listed in description of ‘Shade Type 1’ and ‘Shade Type 2’ below or comparable product by one of the following:

1. BTX Window Automation, Inc.
2. DFB Sales.
3. Draper Inc.
5. Lutron Electronics Co., Inc.
8. OEM Shades Inc.
9. Shade Techniques, LLC.
10. Silent Gliss USA, Inc.
11. SM Automatic, Inc.

B. Source Limitations: Obtain roller shades from single source from single manufacturer with a minimum of ten years experience in manufacturing products comparable to those specified in this section.

2.2 APPLICATION/SCOPE

A. Roller Shade Schedule:

1. Shade Type 1: Manual operating, chain drive, Light-Filtering Fabric roller shades in all exterior windows of the following rooms and spaces listed below and shown on Drawings:

   a. All perimeter offices and office support spaces at floors L1 through L4 labeled as:

      1) Administrative Assistant
      2) Administrative Director
      3) Assistant Director’s Office
      4) Associate Director
      5) Data Analyst
      6) Department Head Office
      7) Director’s Administrative Office
      8) Director’s Office
      9) Faculty Office
     10) Faculty Office w/ Research Space
     11) Office of the Benefit Chair
     12) Post Doc
     13) Post Doctoral Fellow
     14) Professional Staff
     15) Project Office
     16) Research Associate
     17) Research Office
     18) Research Staff/Post Doc
     19) Staff Assistant
     20) Support Space
     21) Undergraduate PIC
22) Visiting Faculty Office

b. Perimeter rooms not labeled as an office or office support space at floors L1 through L4:
   1) Conference Classroom (116) including window facing onto Stair C
   2) Conference Room (232)
   3) Conference Room (312) including window facing onto Stair C
   4) Remote Data Collection Lab (406)
   5) Women’s Toilet Room (R425)
   6) Men’s Toilet Room (R424)
   7) Office Services (433)
   8) Meeting/Work Room (434)

c. All interior windows at office and office support spaces at floors L1 through L4 labeled as:
   1) Support Space (116A)
   2) Receptionist and visitor Area (219)
   3) Staff Assistant (219A) interior window shared with 218
   4) Administrative Assistant (219B)
   5) Graduate PIC (219C)
   6) Work Study (219F) interior window shared with 218
   7) Receptionist and Visitor Area/ Hourly Wage Space (314) interior window shared with 311
   8) Copier Room (313A) interior window shared with 311
   9) Graduate Assistants (413) interior window shared with 412
   10) Office Services Area (417) window facing onto Stair C
   11) Printer Room (417A) window facing onto Stair C
   12) Faculty Office (416) window facing onto Stair C

2. Shade Type 2: Motorized interior operated blackout shade in all exterior windows of the following rooms listed below and shown on Drawings and related motor control systems:

   a. Room # 218
   b. Room # 311
   c. Room # 412
   d. Provide blackout shades in observation windows at rooms 026, 104 and 204, complete with blackout jambs and sills.

2.3 ROLLER SHADE TYPE 1: MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

A. Drive Bracket/Brake Assembly:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Drive Bracket model M5 roller shades without fascia with end caps, as manufactured by MechoShade Systems, Inc; or a comparable product.
   2. Bracket model shall be fully integrated with all accessories, including, but not limited to: room darkening side / sill channels, center supports and connectors for multi-banded shades as indicated on Shop Drawings.
   3. M5 drive sprocket and brake assembly shall rotate and be supported on a welded 3/8 inch (9.525 mm) steel pin.
   4. The brake shall be an over-running clutch design which disengages to 90 percent during the raising and lowering of a shade. The brake shall withstand a pull force of 50 lbs. (22 kg) in the stopped position.
5. The braking mechanism shall be applied to an oil-impregnated hub on to which the brake system is mounted. The oil impregnated hub design includes an articulated brake assembly, which assures a smooth, non-jerky operation in raising and lowering the shades. The assembly shall be permanently lubricated. Products that require externally applied lubrication and or not permanently lubricated are not acceptable.

6. The entire M5 assembly shall be fully ceiling mounted on the steel support bracket, and fully independent of the shade tube assembly, which may be removed and reinstalled without effecting the roller shade limit adjustments.

B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.

   a. Loop Length: As indicated on Drawings.
   b. Chain-Retainer Type: Chain tensioner, as indicated in Shop Drawings.

2. Position of Clutch Operator: As indicated on Drawings or in window schedule.
3. Clutch: Capacity to lift size and weight of shade; sized to fit roller or provide adaptor.
4. Lift-Assist Mechanism: Manufacturer's standard spring assist for balancing roller shade weight and lifting heavy roller shades.
5. Shade Coupler System: Designed for simultaneously operating two or more shade rollers with a single chain drive. Provide system where indicated on Drawings or where indicated in a window treatment schedule.
6. Operating Function: Stop and hold shade at any position in ascending or descending travel.

C. Drive Chain: #10 qualified stainless steel chain rated to 90 lb. (41 kg) minimum breaking strength. Nickel plate chain shall not be accepted.

D. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shade bands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shade bands for service.

1. Roller Drive-End Location: As indicated on Drawings.
2. Direction of Shadeband Roll: Regular, from back of roller or Reverse, from front of roller as indicated on Drawings.
3. Shadeband-to-Roller Attachment: Removable spline fitting integral channel in tube. See 'Shade Band' Section 2.6 below.

E. Mounting Hardware: Brackets to be corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

F. Provide for universal, regular and offset drive capacity, allowing drive chain to fall at front, rear or non-offset for all shade drive end brackets. Universal offset shall be adjustable for future change.

G. Provide shade hardware constructed of minimum 1/8-inch (3.18 mm) thick plated steel or heavier as required to support 150 percent of the full weight of each shade.

H. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
1. Provide shade hardware system that allows for operation of multiple shade bands (multi-banded shades) by a single chain operator, subject to manufacturer's design criteria. Connectors shall be offset to assure alignment from the first to the last shade band.

2. Provide shade hardware system that allows multi-banded manually operated shades to be capable of smooth operation when the axis is offset a maximum of 6 degrees on each side of the plane perpendicular to the radial line of the curve, for a 12 degrees total offset.

I. Shadebands:


2. Shadeband Bottom Hem) Bar: Steel or extruded aluminum.
   a. Type: Enclosed in sealed pocket of shadeband material.
   b. Color and Finish: As selected by Architect from manufacturer's full range.

J. Installation Accessories:

1. Closure: Continuous Aluminum extrusion that conceals roller and operating mechanism; see Drawings.
   a. Shape: L-shaped.
   b. Horizontal depth: 2 inch Closure with Single Closure Mount
   c. Height: Manufacturer's standard height; see Drawings.
   d. Notching of Closure for manual chain shall not be acceptable.

2. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.4 ROLLER SHADE TYPE 2: MOTOR-OPERATED, SINGLE-ROLLER SHADES

A. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

1. Electrical Components: Listed and labeled as defined in NFPA 70, either UL or ETL or other testing agency acceptable to authorities having jurisdiction, and marked for intended location and application and tested as a system. Individual testing of components will not be acceptable in lieu of system testing.

2. Electric Motor Basis-of-Design Product: Subject to compliance with requirements, provide "Electro III" tubular, enclosed in roller without fascia with end caps, as manufactured by MechoShade Systems, Inc; or a comparable product.
   a. Electrical Characteristics: Single phase, \[24\] \[110\] \[220\] <Insert value> V, 60 Hz.

3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:
   a. Individual/Group Control Station: [Maintained] [Momentary]-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for individual and group control.
   b. Color: As selected by Architect from manufacturer's full range.
4. Crank-Operator Override: Crank and gearbox operate shades in event of power outage or motor failure.
5. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.
6. Operating Features:
   a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.
   b. Capable of interface with audiovisual control system.

B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
   1. Roller Drive-End Location: As indicated on Drawings.
   2. Direction of Shadeband Roll: Regular, from back of roller.

C. Mounting Hardware: Brackets to be corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

D. Shadebands:
   2. Shadeband Bottom Hem Bar: Steel or extruded aluminum.
      a. Type: Enclosed in sealed pocket of shadeband material.
      b. Color and Finish: As selected by Architect from manufacturer's full range.

E. Installation Accessories:
   1. Closure: Continuous Aluminum extrusion that conceals roller and operating mechanism; see Drawings.
      a. Shape: L-shaped.
      b. Horizontal depth: 3 inch Closure with Single Closure Mount
      c. Height: Manufacturer's standard height; see Drawings.
      d. Notching of Closure for manual chain shall not be acceptable.
   2. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
      a. Provide side channels for shades in observation windows at rooms 026, 104 and 204.
   3. Bottom Sill Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
      a. Provide bottom sill channel or angle for shades in observation windows at rooms 026, 104 and 204.
4. Installation Accessories Color and Finish: As selected from manufacturer's full range.

### 2.5 SHADEBAND MATERIALS

A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Light-Filtering Fabric for Roller Shade Type 1: Woven fabric, stain and fade resistant.
   2. Type: fabricated from polyester core yarn, single thickness non-raveling
   4. Thickness: 0.030 inch (0.762 mm) thick fabric
   5. Weight: 14.4 oz./sq. yd.
   6. Roll Width: MechoShade stocks in 96 inches.
   7. Orientation on Shadeband: As indicated on approved Shop Drawings
   8. Openness Factor: 3 percent.
   9. Color: As selected by Architect from manufacturer's full range.

C. Light-Blocking Fabric for Roller Shade Type 2: Opaque fabric, stain and fade resistant.
   2. Type: comprising of 53% fiberglass, 45% acrylic, 2% poly finish.
   3. Thickness: .008 inches thick (.19 mm) blackout material
   4. Weight: 15.1 oz./sq. yd.
   5. Roll Width: MechoShade stocks in 100 inches.
   6. Orientation on Shadeband: As indicated on approved Shop Drawings
   7. Features: Contact MechoShade or manufacturer for cleaning instructions
   8. Color: As selected by Architect from manufacturer's full range.

### 2.6 SHADE BAND

A. Shade Bands: Construction of shade band includes the fabric, the hem weight, hem-pocket, shade roller tube, and the attachment of the shade band to the roller tube. Sewn hems and open hem pockets are not acceptable.

B. Hem Pockets and Hem Weights: Fabric hem pocket with RF-welded seams (including welded ends) and concealed hem weights. Hem weights shall be of appropriate size and weight for shade band. Hem weight shall be continuous inside a sealed hem pocket. Hem pocket construction and hem weights shall be similar, for all shades within one room.

C. Shade Band and Shade Roller Attachment:
   1. Use extruded aluminum shade roller tube of a diameter and wall thickness required to support shade fabric without excessive deflection. Roller tubes less than 1.55 inch (39.37 mm) in diameter for manual shades, and less than 2.55 inches (64.77 mm) for motorize shades are not acceptable.
   2. Provide for positive mechanical engagement with drive / brake mechanism.
   3. Provide for positive mechanical attachment of shade band to roller tube; shade band shall be made removable / replaceable with a "snap-on" snap-off" spline mounting,
without having to remove shade roller from shade brackets. Friction fit connectors for drive mechanism connection to shade roller tube are not acceptable.

4. Mounting spline shall not require use of adhesives, adhesive tapes, staples, and/or rivets.
5. Any method of attaching shade band to roller tube that requires the use of adhesive, adhesive tapes, staples, and/or rivets are not acceptable.

2.7 ROLLER-SHADE FABRICATION

A. Product Description: Roller shade consisting of a roller, a means of supporting the roller, a flexible sheet or band of material carried by the roller, a means of attaching the material to the roller, a bottom bar, and an operating mechanism that lifts and lowers the shade.

B. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
   1. Lifting Mechanism: With permanently lubricated moving parts.

C. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.

D. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F:
   1. Shade Units Installed between (Inside) Jambs: Edge of shade not more than 1/4 inch from face of jamb. Length equal to head to sill dimension of opening in which each shade is installed.
   2. Shade Units Installed Outside Jambs: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
   3. Fabricate units to completely fill existing openings from head to sill, unless specifically indicated otherwise. All manual shades must be multi-banded in curtain wall glass system.

E. Fabricate shadecloth to hang flat without buckling or distortion. Fabricate with heat-sealed trimmed edges to hang straight without curling or raveling. Fabricate unguided shadecloth to roll true and straight without shifting sideways more than 1/8 inch (3.18 mm) in either direction per 8 feet (2438 mm) of shade height due to warp distortion or weave design. Fabricate hem as follows:
   1. Bottom hem weights

F. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:
   1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.
   2. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.
   3. For railroaded shadebands, provide seams in railroaded multi-width shadebands as required to meet size requirements and in accordance with seam alignment as acceptable to Architect. Seams shall be properly located. Furnish battens in place of plain seams when the width, height, or weight of the shade exceeds manufacturer's standards. In absence of such standards, assure proper use of seams or battens as required to, and assure the proper tracking of the railroaded multi-width shadebands.
G. Installation Brackets: Designed for easy removal and reinstallation of shade, for supporting and operating hardware and for hardware position and shade mounting method indicated.

H. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.

I. Color-Coated Finish: For metal components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.
   1. Four color finishes will be required.

J. Colors of Metal and Plastic Components Exposed to View: As selected by Architect from manufacturer's full range of standard and custom colors, unless otherwise indicated.

2.8 COMPONENTS

A. Access and Material Requirements:
   1. Provide shade hardware allowing for the removal of shade roller tube from brackets without removing hardware from opening and without requiring end or center supports to be removed.
   2. Provide shade hardware that allows for removal and re-mounting of the shade bands without having to remove the shade tube, drive or operating support brackets. Use only Delrin engineered plastics by DuPont for all plastic components of shade hardware. Styrene based plastics, and/or polyester, or reinforced polyester will not be acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 ROLLER-SHADE INSTALLATION

A. Install roller shades level, plumb, square, true and aligned with adjacent units according to manufacturer's written instructions.

   1. Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.
B. Contractor to provide blocking within wall construction as required for proper support and anchorage of roller shade assemblies.

C. Electrical Connections: Connect motor-operated roller shades to building electrical system.

3.4 ADJUSTING

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.5 CLEANING AND PROTECTION

A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that roller shades are without damage or deterioration at time of Substantial Completion.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain roller shades and motor-operated roller shades. Refer to Division 01 Section Demonstration and Training."

3.7 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:

1. Aluminum
2. Plastic Materials and Gaskets
3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:

1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 12 24 13
SECTION 12 48 13 - FLOOR MATS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Modular entrance floor panels in recessed frames.

B. Related Sections include the following:
   1. Division 03 Section "Cast-in-Place Concrete" for slab depression for recessed mats and frames, and topping slab required to bring top of mat to height level with adjacent finish floor.

1.3 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Show the following:
   1. Items penetrating floor mats and frames, including structural columns and other items shown on the Drawings.
   2. Divisions between mat sections.
   3. Perimeter floor moldings.

C. Samples for Initial Selection: For each type of product indicated.

D. Samples for Verification: For each type of product indicated.
   1. Floor Panel: 12-inch-square, assembled sections of floor mat.
   2. Frame Members: 12-inch-long Sample.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For floor mats and frames to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Entrance Panels: Full-size units equal to 2 percent of amount installed for each size, color, and pattern indicated, but no fewer than 10 units.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain floor mats and frames through one source from a single manufacturer.

B. Accessibility Requirements: Provide installed floor mats that comply with Section 4.5 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
C. Performance Data:
1. Certified by the NFSI as safe walking surface meets .6 wet SCOF.
2. Provide a 500 lb per wheel rolling load.
3. Class I Fire Rated.
4. Considered permanent grille or grate as recommended in LEED IAQ Credit 5.
5. Removes 98% of foot traffic contaminants within 18’ of walking surface.

1.7 PROJECT CONDITIONS
A. Field Measurements: Indicate measurements on Shop Drawings.

1.8 COORDINATION
A. Coordinate size and location of recesses in concrete with installation of finish floors to receive floor mats and frames.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Stainless Steel – Type 304 Stainless Steel.
B. Aluminum – ASTM 221, alloys 6061-T5, 6063-T6, 6210-T5, and 6005-T5 for extrusions, sheet, or plate.

2.2 FLOOR MATS / GRIDS
A. Basis-of-Design Product: Subject to compliance with requirements, provide Floorometry 201 as manufactured by Construction Specialties, or an approved equal.
B. Stainless Steel Mesh Panels:
1. Panel Size: 18” x 18” x ¾”.
2. Mesh: Flat Weave, with thickness of .150” and 36.9% free area.
3. All components to be T304 Stainless Steel.
4. Substructure of .090” thick perimeter s.s. banding and s.s. intermediate supports with a horizontal drain feature.
5. All components tack welded.
6. Panels are removable and replaceable.
7. Finish: Mill.
8. Weight: 11.7 lbs per panel.

C. Recessed Frames:
1. All components to be T304 Stainless Steel.
2. ¾” deep frame with 1/8” exposed surface.

2.3 COMMON MUD PLATE AND BOND BREAKER
A. Product includes a common mud plate and bond breaker. The aluminum mud plate attaches to the slab with the manufacturer’s recommended adhesive. Integral to the mud plate is the bond breaker, preventing the flooring adhesive from bonding to the top surface of the product. The bond breaker also provides the base of the collection reservoir which contains all contaminates removed and collected from foot traffic. Top surface sections are removable, using common integral attachment clips allowing for periodic maintenance by vacuuming the reservoir or power washing the product.
Each mud plate comes with four alignment pins to ensure a proper and quick connection of the removable surface to the common base. Surface removal tools to be included.

2.4 ADHESIVES

A. Basis-of-Design Adhesives:
   1. Provide adhesives recommended by product manufacturer.
      a. Henry 130 Thin Spread Floor Tile Adhesive – Interior Use only.
      b. Laticrete Latapoxy 300 Adhesive – Interior or Exterior Use.

2.5 FABRICATION

A. Floor Mats: Shop fabricate units to greatest extent possible in sizes indicated. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints.

B. Recessed Frames: As indicated, for permanent recessed installation, complete with corner pins or reinforcement and anchorage devices.
   1. Fabricate edge-frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.

C. Coat surfaces of aluminum frames that will contact cementitious material with manufacturer's standard protective coating.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and floor conditions for compliance with requirements for location, sizes, and other conditions affecting installation of floor mats and frames.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install recessed mat frames to comply with manufacturer's written instructions. Set mat tops at height recommended by manufacturer for most effective cleaning action; coordinate top of mat surfaces with bottom of doors that swing across mats to provide clearance between door and mat.
   1. Install necessary shims, spacers, and anchorages for proper location and secure attachment of frames.
   2. Install grout and fill around frames and, if required to set mat tops at proper elevations, in recesses under mats. Finish grout and fill smooth and level.

B. Install surface-type units to comply with manufacturer's written instructions at locations indicated; coordinate with entrance locations and traffic patterns.
   1. Anchor fixed surface-type frame members to floor with devices spaced as recommended by manufacturer.

3.3 PROTECTION

A. After completing frame installation and concrete work, provide temporary filler of plywood or fiberboard in recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.
3.4 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum.
   2. Plastic Materials
   3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 12 48 13
SECTION 12 61 00 - FIXED SEMINAR TABLES  [C]

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes fixed, continuous seminar tables with the following:

2. Table top design: continuous worksurface, straight; see Drawings
3. Modesty Panels: unitized, straight; see Drawings
4. End Panels: project specific dimensions; see Drawings
5. Power service to individual table locations; see Drawings
6. Row ID on table tops; see Drawings

B. Related Sections:

1. Division 1 Section "Sustainable Design Requirements" for additional LEED requirements.
2. Division 26 Sections for electrical service and connections to table junction box locations for power receptacles.

C. LEED Opportunities: This Section has opportunities for the following LEED points:

1. Materials and Resources Prerequisite 1 and Credits 2.1, 4.1 and 4.2 (10% and 20% Recycled Content – post-consumer/pre-consumer) and 5.1 (Regional Materials)
2. Indoor Environmental Quality Credit 4.1.
3. Greenguard Certified - Low Emitting Materials
4. Renewable Materials
5. FSC Certified Wood

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fixed seminar tables. Include electrical characteristics.

B. LEED Submittals:

1. Certificates for Credit MR 6 Credit MR 7: Chain-of-custody certificates certifying that wood and wood-based materials comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
2. Product Data for Credit IEQ 4.4: For each composite wood product, documentation indicating that product contains no urea formaldehyde.
3. Laboratory Test Reports for Credit IEQ 4: For composite wood products
4. Recycled Content Summary:

a. Steel:
   1) average % by weight: 28%
   2) Recycled content: 28%
   3) % Post Consumer: 18%
   4) % Pre Consumer: 17%
   5) Recyclable: Yes

b. Particle Board:
   1) average % by weight: 54%
   2) Recycled content: 100%
   3) % Post Consumer: 40%
   4) % Pre Consumer: 60%
   5) Recyclable: No

c. Laminate:
   1) average % by weight: 9%
   2) Recycled content: 10%
   3) % Post Consumer: 0%
   4) % Pre Consumer: 10%
   5) Recyclable: Yes

5. Greenguard Certification
6. Certified Wood
7. No-Added Urea Formaldehyde

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Table Layout: Show Table layout, aisle widths, and row-lettering scheme, table widths, and table support base and pedestal spacing in each row. Coordinate base and pedestal locations with number of seats per row. See Drawings for seat count per row.
   2. Accessories: Show accessories, including locations of, electrical devices, accessibility provisions, and attachments to other work. Coordinate electrical device locations with number of seats per row. See Drawings for seat count per row.
   3. Wiring Diagrams: For power, signal, and control wiring.

D. Samples for Initial Selection: For each type of exposed finish, color, texture, and pattern indicated. All finishes (wood, laminate, veneer, metal and plastic) as selected by architect from manufacturer's full range of standard and premium color and finishes.

E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
   1. Plastic Laminate: Manufacturer's standard-size unit, not less than 3 inches (75 mm) square.
   2. Baked-on Coating Finishes: Manufacturer's standard-size unit, not less than 3 inches (75 mm) square.
   3. Aluminum Finishes: Manufacturer's standard-size unit, not less than 3 inches (75 mm) square.
   4. Wood and Plywood Materials and Finishes: Manufacturer's standard-size unit, not less than 3 inches (75 mm) square.
5. Row-Letter and Table-Number Plates: Full-size units with letters and numbers marked.
7. Exposed Fasteners: Full-size units of each type.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.
B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fixed seminar tables to include in maintenance manuals. Include the following:
   1. Precautions for cleaning materials and methods that could be detrimental to table finishes and performance.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials from the same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Power Receptacles: Furnish a quantity of full-size units equal to 5 percent of amount installed.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of table required, including accessories and mounting components, from single source from single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockups for the following types of fixed seminar tables including finishes, and accessories:
      a. Typical row with continuous modesty panel and end panel
      b. Typical row without modesty and end panels
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
D. Preinstallation Conference: Conduct conference at Project site.
1.8  PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install tables until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary or permanent HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Field Measurements: Verify actual dimensions of table layout and construction contiguous with tables by field measurements before fabrication.

1.9  COORDINATION

A. Coordinate layout and installation of electrical wiring and devices with table layout to ensure that floor junction boxes for electrical devices are accurately located to allow connection without exposed conduit.

1. Coordinate wiring and power receptacles installed in tables with requirements in Division 26 Sections.

1.10 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of fixed seminar tables that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures including base and pedestals.
   b. Faulty operation of electrical components.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Periods: As follows, from date of Substantial Completion.

   a. Structural: Lifetime.
   b. Electrical Components: Ten years.

PART 2 - PRODUCTS

2.1  MATERIALS AND FINISHES

A. Steel: ASTM A 36/A 36M plates, shapes, and bars; ASTM A 513 mechanical tubing; ASTM A 1008/A 1008M cold-rolled sheet; and ASTM A 1011 hot-rolled sheet and strip.

B. Cast Iron: ASTM A 48/A 48M, Class 25 (Class 175), gray iron castings free of blow holes and hot checks with parting lines ground smooth.

C. Cast Aluminum: ASTM B 85 aluminum-alloy die castings.
D. Metal Finish: Finish exposed metal parts with manufacturer's standard minimum 1.5-mil (0.04-mm) thick, epoxy baked-on powder coating.

   1. Color: As selected by Architect from manufacturer's full range of standard and premium colors.

E. Certified Wood: Fabricate tables with wood components produced from wood obtained from Retain option in first three paragraphs below if required for LEED-NC, LEED-CI, or LEED-CS Credit IEQ 4.4.

F. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.

G. Concealed Plywood: HPVA HP-1 hardwood plywood, made with adhesive containing no urea formaldehyde, or DOC PS 1 softwood plywood, as standard with manufacturer.

H. Hardwood Lumber and Veneer Faces: Cherry selected to be free of visible defects.

   1. Stain and Finish: As selected by Architect from manufacturer's full range of standard and premium stains and finishes.

I. Plastic Laminate: NEMA LD 3, Grade VGS for vertical surfaces and Grade HGS for horizontal surfaces.

   1. Color and Pattern: As selected by Architect from manufacturer's full range of standard and premium color and pattern.

2.2 FIXED SEMINAR TABLES

A. Fixed Seminar Tables: Interior seminar tables in permanent arrangement shown on Drawings.

   1. Basis-of-Design Product: Subject to compliance with requirements, provide KI "Fixed Worksurface Solutions".

B. Table Mounting Base and Pedestal:

   1. Basis-of-Design Product: Subject to compliance with requirements, provide KI basic (rectangular) base style.

C. Continuous Straight Table Top:

   1. Basis-of-Design Product: Subject to compliance with requirements, provide KI "Fixed Worksurface Solutions".

      a. Laminate with 34S edge (square wood band): As selected by Architect from manufacturer's full range.
      b. Size: see Drawings for custom row length; depth 24"
      c. Note: modesty panels only occur at edge of floor riser, no modesty panels at intermediate rows of tables

D. Table Height: 29" high; compliant with ADA.

E. Modesty Panels: Unitized.
   a. Perforated wood with 34S edge (square wood band): As selected by Architect from manufacturer's full range.
   b. Size: see Drawings for custom height of modesty panel to correspond with stepped risers at Lecture Hall.
   c. Note: modesty panels only occur at edge of floor riser, no modesty panels at intermediate rows of tables

F. End Panels:
      a. Perforated wood with 34S edge (square wood band): As selected by Architect from manufacturer's full range.
      b. Size: see Drawings for custom height of end panel to correspond with and follow profile of stepped risers at Lecture Hall.
      c. Note: end panels only occur at edge of floor riser, no end panels at intermediate rows of tables

G. Power Service Package: Manufacturer's standard service to individual tables including terminal devices and wiring with 18 inches (457 mm) of extra length and as follows.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide KI “PowerUp System”. Each module encloses one duplex receptacle (two power outlets).
   2. Location: See Drawings
   3. Quantity: One module per two seats (200 seats total; round up quantity for rows with an odd number of seats – total required 102).
   5. Seminar tables with “PowerUp” system: an eight-wire, four-circuit pre-wired harness is wired to the building power source and handles up to 24 laptops or 12 PC’s per power infeed. “PowerUp” components are completely enclosed below the worksurface within durable, tamper-resistant troughs and shrouds. Only the access module is visible on the worksurface.

H. Row-Letter and Table-Number Plates: Manufacturer's standard.
   1. Material: Stainless steel with black embossed characters.
   3. Row ID is not shown on Drawings. Row letter designation plates shall be mounted to end panels. Seat Number designation plates shall be recessed into wood table edge at each seat location, centered in edge. [C]

I. Seating: non-fixed individual chairs (not in contract)

2.3 FABRICATION

A. Floor Attachments: Fabricate to conform so that base and pedestals, tabletop, modesty and end panels are plumb, and, tables are maintained at same height above finish floor throughout Project.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine floors, risers, and other adjacent work and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine locations of electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install tables in locations indicated and fastened securely to substrates according to manufacturer's written installation instructions.

   1. Install base and pedestals plumb.

B. Install wiring conductors and cables concealed in components of tables and accessible for servicing.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

   2. Tests for Power Receptacles: As specified in Division 26 Sections.

B. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust tables so that they are aligned with each other in straight rows.

B. Verify that all components and devices are operating properly.

C. Repair minor abrasions and imperfections in finishes with coating that matches factory-applied finish.

3.5 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:

   1. Aluminum
2. Plastic Materials and Gaskets
3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
   1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 12 61 00
SECTION 12 9300 - SITE FURNISHINGS [C]

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Metal Benches.
   2. Wood Benches
   3. Bicycle racks.
   4. Trash receptacles.
   5. Vehicular Bollards.
   6. Pedestrian Bollards
   7. Emergency Call box
   8. Lawn Terrace Step Handrails

B. Related Sections include the following:
   1. Division 3 Section "Cast-in-Place Concrete" for installation of pipe sleeves cast
      installation of anchor bolts cast in concrete footings.

C. Products furnished, but not installed under this Section, include anchor bolts and cast in
   concrete footings.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection: For units with factory-applied color finishes.

C. Samples for Verification: For each type of exposed finish required, prepared on Samples of
   size indicated below.
   1. Size: Not less than 6-inch long linear components and 4-inch square sheet components.
   2. Paint samples for benches and receptacles matching PSU Facilities campus standards.

D. Product Schedule: For site furnishings. Use same designations indicated on Drawings.

E. Material Certificates: For site furnishings, signed by manufacturers.

F. Maintenance Data: For site furnishings to include in maintenance manuals.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of site furnishing(s) through one source from a single
   manufacturer.
1.4 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Bench Replacement Slats  No fewer than two full-size units for each size indicated.
2. Trash Receptacle Inner Containers: 5 full-size units for each size indicated, but no fewer than 2 units.
3. Anchors:  One per assembly

PART 2 - PRODUCTS

2.1 HANDRAIL MATERIALS

A. University Campus Standard Aluminum: Alloy and temper recommended by aluminum producer and finisher for brushed aluminum finish indicated; free of surface blemishes and complying with the following:

1. Rolled or Cold-Finished Bars, Rods, and Wire: ASTM B 211M.
2. Extruded Bars, Rods, Wire, Profiles, and Tubes: ASTM B 221M.
4. Sheet and Plate: ASTM B 209M.
5. Castings: ASTM B 26/B 26M.

B. Anchors, Fasteners, Fittings, and Hardware: Stainless steel and Manufacturer's standard, corrosion-resistant-coated; commercial quality, tamperproof, vandal and theft resistant as per details.

C. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107; recommended in writing by manufacturer, for exterior applications.

D. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound; resistant to erosion from water exposure without needing protection by a sealer or waterproof coating; recommended in writing by manufacturer, for exterior applications.

2.2 BENCHES

A. Metal Bench: University Campus Standard.
2. Model: Plainwell, Horizontal Strap; backed with arms 72" length,
3. Finish: Black powdercoated,
4. Quantity: 1

B. Wood Bench: University Campus Standard,
2. Model: ’Monarch’, Teak Bench, 72” Length
3. Quantity: 6
4. Installation Method: Attached to Stainless Steel dowel epoxy into concrete base, as shown on the attached details.

2.3 SEATING AND TABLES

A. Café Tables:
1. Type: As Manufactured by Landscape Forms, Inc: Heavy Gauge ‘STEELHEAD’ Type with perforated metal top framed by 1-1/2” tube. Size shall be 42” diameter. Provide the quad freestanding table legs.
2. Finish: Stainless Steel with clear Pangard II polyester powdercoat protection. [C]
3. Quantity: 6
4. Movable, no attachment.

B. Chairs:
1. Type: As Manufactured by Landscape Forms, Inc: Heavy Gauge ‘TRAVERSE’ Chairs without arms, with 7/8” diameter tubular steel frame with perforated metal seat inserts.
2. Finish: Stainless Steel with clear Pangard II polyester powdercoat protection. [C]
3. Quantity: 24
4. Movable, no attachment.

2.4 BICYCLE RACKS

A. Type: University Campus Standard,
2. Model: Cora Bike Rack, Expo # 7510,
3. Size: 6Ft long, 74-3/8” pin to pin; 34” height. 30” depth,
4. Color: Comet Black,

B. Quantity: 4

C. Installation Method: Bolted to cast-in place concrete pad.

2.5 TRASH RECEPTACLES

A. Type: University Campus Standard,
2. Model: Midtown 32 with Lid, # MT3D-32/Lid=LID32,
3. Receptacle with door, elevated legs and elevated lid,
4. Size: 32 gallon,
5. Color: Black powdercoated

B. Quantity: 4. [C]

C. Installation Method: Bolted to concrete pads as per manufactures recommendation.
2.6 PEDESTRIAN BOLLARDS-POST AND CHAIN

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

B. Post: University Campus Standard,
   2. PSU Aluminum Fence Post
      a. Model 14424
      b. Description: 5 Ft. tall, ball-topped with chain rings; post to be spaced 9Ft. on center.
      c. Size: 5 Ft. overall length (3 Ft Exposed)
   3. Finish: Ridge Black Powdercoated

C. Chain: University Campus Standard
   1. 1/4” grade 30 proof coil chain; black vinyl coated.

2.7 EMERGENCY CALL BOX

A. Type: University Campus Standard,
   1. Manufacturer: Code Blue Corporation, 92 East 64th Street Holland, MI 49423, Phone 800-205-7186, Web: www.codeblue.com
   2. Model: CB-5,
   3. Description: Freestanding type; with lighted faceplate; Blue beacon,
   4. Size- Diam.-8-3/4” / Ht.-9’-6”,

B. Quantity: 1

C. Installation Method: Attached to embedded bolts in concrete footing as per manufactures recommendations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance.

   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturers written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
C. Install site furnishings level, plumb, true, and securely anchored and positioned at locations indicated on Drawings.

D. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.

E. Pipe Sleeves for Removable Vehicular Bollards: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

3.3 CLEANING

A. After completing site-furnishing installation, inspect components. Remove spots, dirt, and debris. Repair damaged finishes to match original finish or replace component.

END OF SECTION-12 9300
SECTION 14 20 00 – ELEVATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes Machine Room-Less (MRL) passenger elevators.

B. Related Requirements:
   1. Division 01 Section “Temporary Facilities and Controls” for temporary use of elevators for construction purposes.
   2. Division 03 Section “Cast-in-Place Concrete” for setting sleeves, inserts, and anchoring devices in concrete.
   3. Division 04 Section “Unit Masonry” for setting sleeves, inserts, and anchoring devices in masonry and for grouting elevator entrance frames installed in masonry walls.
   4. Division 05 Section “Metal Fabrications” for the following:
      a. Attachment plates and angle brackets for supporting guide-rail brackets.
      b. Hoist beams.
      c. Structural-steel shapes for subsills.
      d. Pit ladders.
      e. Cants in hoistways made from steel sheet.
   5. Division 09 painting Sections for field painting of hoistway entrance doors and frames.
   6. Division 22 Section “Sump Pumps” for sump pumps, sumps, and sump covers in elevator pits.
   7. Division 26 Sections for electrical service for elevators to and including fused disconnect switches at machine room door and standby power source, transfer switch, and connection from auxiliary contacts in transfer switch to elevator controllers.
   8. Division 27 Section “Communications Horizontal Cabling” for telephone service for elevators.
   9. Division 28 Section “Digital, Addressable Fire-Alarm System” for smoke detectors in elevator lobbies to initiate emergency recall operation and heat detectors in shafts and machine rooms to disconnect power from elevator equipment before sprinkler activation and for connection to elevator controllers.

1.3 DEFINITIONS

A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.

B. Service Elevator: A passenger elevator that is also used to carry freight.
1.4 ACTION SUBMITTALS

A. Product Data: Include capacities, sizes, performances, operations, electrical characteristics and connection requirements, safety features, controls, finishes, operating fixtures, operating panels, and similar information.

B. Shop Drawings:
   1. Include plans, elevations, sections, and large-scale details indicating service at each landing, control room layout, coordination with building structure, relationships with other construction, and locations of equipment.
   2. Include large-scale layout of car-control station and standby power operation control panel.
   3. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
   4. Field measure locations of specified equipment prior to ordering shop drawings. Verify field measurements are as indicated on shop drawings prior to submitting.

C. Samples for Initial Selection: For finishes involving color selection.

D. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes; 3-inch- (75-mm-) square Samples of sheet materials; and 4-inch (100-mm) lengths of running trim members.

E. Cut sheets: Include cut sheets of all fixtures, and all lighting, including luminaries, lamps and ballast controls.

F. All submittals shall be in PDF format.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and control closet layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.

C. Sample Warranty: For special warranty.

D. All submittals shall be in PDF format.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.

   1. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include diagnostic and repair information available to manufacturer's and Installer's maintenance personnel.
   2. Include parts listing with sources indicated, recommended parts inventory listing, emergency instructions, necessary maintenance tools, and similar information.

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
C. Regulatory Requirements: In addition to local governing regulations, comply with the applicable provisions of ASME A17.1, 2000 Safety Code for Elevators and Escalators including all addenda through 2002.

1. NFPA 70.
2. As supplemented in this section.
3. The Americans with Disabilities Act (ADA).
4. ASTM A 36 – Structural Steel.
7. ASTM B221 Aluminum and aluminum alloy extruded bars, rods, wires, shapes, and tubes.

D. Continuing Maintenance: The elevator contractor shall furnish full elevator equipment maintenance for a period of twelve (12) months after Substantial Completion. Full maintenance shall include regular monthly examinations of the installation by competent personnel and shall include all necessary adjustments, repairs, lubricating, cleaning and the needed supplies, etc., too keep the equipment in first class condition, except for misuse, accidents, or negligence not caused by the elevator contractor. The elevator contractor shall supply 24 hour 7 days per week emergency callback service during the maintenance period. A yearly full maintenance quotation based on 24-hour callback service and a full parts warranty shall accompany this installation quotation.

E. All submittals shall be in PDF format.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Elevator service company specializing in performing the work of this section and approved by the elevator equipment manufacturer. Installer shall be on Penn State University Pre-Qualification List.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.9 COORDINATION

A. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.

B. Coordinate locations and dimensions of other work relating to electric traction elevators including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.10 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.

1. The elevator contractor shall guarantee that the materials and workmanship of the apparatus installed by him under these specifications shall be first-class in every respect. The
contractor will repair or replace any defective components, not due to ordinary wear and tear or improper use, which may develop within one (1) year from date of Substantial Completion. Written warranties shall be provided to the University before final payment.

2. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by the following:
   1. Hollister Whitney MRL (Basis of specification)
   2. Port Elevator Inc, Williamsport, PA
   3. Hollister Whitney / GAL
   4. Approved equal

2.2 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.

B. Accessibility Requirements: Comply with Section 407 in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.

2.3 ELEVATORS

A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturer's standard components shall be used, as included in standard elevator systems and as required for complete system.

B. New MRL machine shall be installed with a Permanent Magnet Gearless AC Traction Machine. Machine shall meet the following:
   1. Permanent magnet gearless traction machine designed for use with a machine-room-less elevator.
   2. 3-phase, 28 pole, synchronous AC gearless motor.
   3. Quantity and type: One (1)
   4. MRL Traction passenger
   5. Capacity: 3500 pounds
   6. Speed: 150 feet per minute
   7. Travel: Basement to Four, distance of approx 56'-0"
   8. Landings: Six (6)
   9. Openings: Five (5) front (1) rear
   10. Operation: Selective collective
   11. Platform size: 7'-0" wide x 6'-7 1/2" deep
   12. Hoistway entrance: Size: 3'-6" wide x 7'-0" high
   13. Type: Single Speed Side Opening – stainless steel
   14. Additional features:
      a. In car directional lanterns.
      b. Gongs.
Controller – Elevator System’s non-proprietary microprocessor-based controller shall be provided, including necessary starting switches together with all, relays, switches, and solid state components required for operation. Microprocessor shall have opto-isolated inputs and outputs. Shall be isolated with Dry Relay contacts. Controller shall have all diagnostic and trouble shooting readouts located directly on the unit. Controller shall have the ability to be replaced by a unit of different model or manufacturer without the necessity of replacing any other related items (door operators, selectors, car station, hall buttons etc). The control system shall include a microprocessor for processing, adjusting and diagnostics. The system shall provide comprehensive means to access the computer memory for elevator adjusting and diagnostic purposes and shall have permanent indicators to show elevator status as an integral part of the controller. Status indicators shall be provided on the controller to indicate when the safety circuit is open, when the door locks are open, when the elevator is running at high speed, with the elevator is on independent service, when the elevator is on fireman’s service, when the elevator out of service timer has elapsed, and when the elevator has failed to successfully complete it’s intended movement. A means shall also be provided for the displaying of other special or error conditions that are detected by the microprocessor without the use of any hand held or portable device. Changing of operational parameters shall be possible without the use of removable devices also. Full set of manuals including parameter lists, faults, settings, passwords and instructions on full use of the processor as well as wiring diagrams shall be included.

1. Controller manufacturers: Subject to compliance with requirements. Provide controller by one of the following manufacturers:
   a. GAL
   b. Elevator Systems
   c. Virginia Controls
   d. University design professional approved equal

2. Remote Monitoring System: Provide and install an interactive system to monitor and manage the elevator equipment. The data collection, data storage and real-time monitoring portion of the system shall be based on Microsoft Windows, and able to run on Windows 95 or later, and Windows NT 4.0 or later operating systems compatible with University systems. The system shall be network-based and be capable of interfacing with all makes and types of elevator control systems. System shall be compatible with any type or age of elevator. The system shall collect data via serial data connections. The system shall be capable of operating on any TCP/IP based network system. The addition of unlimited monitoring terminals shall be possible on the network. Monitoring terminals shall operate “peer to peer” without a single server, and the failure of a single network device shall not affect the operation of the rest of the system. The system shall provide multiple banks, including multiple buildings, on a single monitoring terminal screen. The system shall be capable of simultaneous monitoring of at least one hundred elevator units on a single monitoring station. The system shall be capable of real-time display of all monitored status points on all monitored equipment. Fault and event notification screens and audible alarms shall be immediately displayed on selected monitoring station, based on Boolean logical combinations of the monitored status points. Different vault and event tables shall be defined on a per-bank basis. The system shall collect and store all status, fault and event information for later reporting and analysis. The system shall provide statistical analysis of hall call response times, traffic patterns, fault conditions, service logs and security usage in graphical and tabular format. The system shall maintain a record of every status point change occurring on the monitored equipment, and provide the ability to replay these events in a simulation at a later time in real-time, slow speed, single step, reverse, or fast forward. These features may be revised as the requirements of the building change. Some of these interactive controls may include but are not limited to: security floor lockouts, entering car and hall calls, Fireman’s return service, lobby recall. System shall have the capability to interconnect and monitor all elevator emergency phones. The system shall display and record the following information for each monitored unit: (The following is intended as a guideline - connections to
each status point mentioned on every control system may be impractical. Serial data links may include many more points.) Applies to both hydraulic and traction elevators.

a. Individual car status - expandable menus - including but are not limited to: Direction of travel, Independent service, Fire service, Position of elevator, Door status (open, opening, closing, closed), Door dwell time, Power on/off, Door detector, Safety circuit, Door zone, Stop switch, Alarm button, Registered Car Calls

b. Data ports – Provide one serial data port for connection of an onsite laptop computer, and one cat5 port for future network connection for each elevator controller.

c. Network wiring to be provided by the GC.

d. Contractor to provide interface device to communicate with Elevator controller and University network

D. Motor Control: Variable frequency AC type motor controller.

   1. Limit total harmonic distortion to 5% Per IEEE 519.
   2. Provide means for absorbing regenerated power when elevator system is operating on standby power.

E. Automatic two-way leveling: An automatic two-way leveling device shall be provided so that the car will approach landing stops at reduced speed from either direction of travel. The leveling device shall, within its zone, be entirely independent of the operating device and shall automatically stop and maintain the car approximately level with the landing, regardless of change in load.

F. Restricted opening of hoistway or car doors: When the car is outside the unlocking zone, the doors must be arranged so that the hoistway doors or car doors cannot be opened more than 4” from inside the car. The doors shall be opening able from outside the car with a special tool.

G. Selective Collective Operation: The momentary pressing on one or more car buttons shall send the car to the designated landings in the order in which the landings are reached by the car, irrespective of the sequence in which the buttons are pressed. During this operation the car shall answer calls from the landings which are in the prevailing direction of travel and each call shall be canceled when answered. With the momentary pressing of a hall button above the car, the car shall start up and answer any up calls as they are reached by the car irrespective of the sequence in which the buttons are pressed. The car shall not stop at floors where down buttons only are pressed. Similarly, the car shall start down to answer calls below the car and shall not stop where up calls only are registered. When traveling up, the car shall reverse at the highest call and proceed to answer calls below it. Similarly, when traveling down, the car shall reverse at the lowest call and answer calls above it. Should both an up and down call be registered at an intermediate landing, only the call corresponding to the direction in which the car is traveling shall be canceled upon the stopping of the car at that landing.

H. Car enclosure: The cab shall be similar to the following:

   1. Flush design hollow metal car doors #4 stainless steel finish.
   2. Threshold silver nickel
   3. Entrance columns #4 stainless steel
   4. Front & back panel #4 stainless finish
   5. Side panels: Phenolic raised panels with stainless steel base, trim and reveals.
   7. Hands-free flush mount telephone in compartment
   8. Pad buttons
   9. Fan
   10. Floor finish: Slate.
   12. Vandal Resistant stainless steel signals and buttons with 100,000-hour life LED type indicators.
13. Lighting – Dimmable LED down lighting to provide 19 foot candles minimum at the floor level. Lighting color temp. is 3,000K. 50,000 hour life (to 70% output). Provide occupancy dimming when car is not in use.
   a. LED cab lighting shall also double as emergency lighting.
   b. Suggested Manufacturers:
      1) Man-D-Tec
      2) Cab-Lite (Electronic Controls Incorporated)

14. Cab moving pads installed throughout each elevator for the protection of car interiors.

I. Master door operator: A GAL MOVFR master gearless door operator with AC current motor shall be provided to open and close the car and hoistway doors simultaneously, at a maximum speed of not less than 1 \(\text{feet per second}\). Door movement shall be cushioned or checked at both limits of travel. Electro-mechanical switches and adjustable resistors shall control speed and limits. Electro-mechanical interlock shall be provided on each hoistway door to prevent the operation of the elevator unless all doors are closed and locked. An electric contact shall be provided on the car door to prevent the operation of the elevator unless the car door is closed. The door operator shall be arranged so that, in case of interruption or failure of electric power from any cause, the doors can be readily operated by hand from within the car. Emergency devices and keys for opening the doors from the landing shall be provided as required by the local codes. The doors shall open automatically when the car is leveling at the respective landings, and shall close after a predetermined time interval or immediately on pressing a car button. A “door open” button shall be provided in the car, the momentary pressing of which shall reopen the doors and reset the time interval. Provide clutch lock mechanism to keep doors from opening between floors.

J. Car door protective device – Adams Gatekeeper or GAL MOVFR. When in their full open position, the doors shall be unable to initiate closing if one or more of the beams are interrupted by a person or object. If one or more of the beams are interrupted while the doors are closing, the doors shall stop, then reverse to open. The doors shall reclose after a brief time. Supply a GAL MOVFR programming tool.

K. Door hangers and tracks: Hangers and tracks shall be provided at each car and hoistway entrance. Tracks shall be standard GAL with the working surface contoured to match the sheaves. The hangers shall be designed for power operation and have provisions for vertical and lateral adjustment. Hangers shall be designed for two-point suspension of the door panel. Hanger sheaves shall be polyurethane with pre-lubricated and sealed for life bearings. Car door hangers shall have minimum 3\(\frac{3}{8}\)" diameter sheaves. Hoistway door hangers shall have minimum 3\(\frac{5}{8}\)" diameter sheaves. Zone Clutch lock system shall be utilized to prevent opening of car doors from inside the car when the elevator is out of the door zone.

L. Car frame and platform: The car frame, which supports the elevator platform and enclosure, shall be made of structural steel members. Platform shall consist of a steel frame filled with suitable sub-floor and a finished floor of others. Underside of platform shall be properly fireproofed.

M. Cables: New Hoist and governor cables. New cable Shackles with new wedge clamp shackles. Maintenance to include shortening new cables to compensate for stretching. Shortening of cables to occur by the contractor prior to the end of the one-year maintenance period.

N. Keyed stop switch: A keyed stop switch shall be provided in the car, designated to cut off current supply to motor and bring the car to rest independent of the regular operating devices.

O. Car operating panel – Adams Elevator Equipment or GAL Manufacturing: a flush mounted operating panel shall be furnished in the car containing call registration buttons for each landing, emergency stop switch, alarm button, door open, door close, photo eye, fan, and light switch. Mount panel at heights complying with ASME A17.1. Emergency lighting shall be provided using the cab lighting. All buttons shall be 100,000-hour life LED type vandal resistant stainless steel indicators. All cover plates shall be engraved with the fire logo, “In Case of Fire Use Stairs”, the no smoking logo, and
"No Smoking". Furnish and install 'Best' key switches for floor cutouts and independent service features. Penn State elevator number in the panel face.

P. Hall buttons: Adams Elevator Equipment or GAL Manufacturing: A riser of flush mounted buttons shall be provided. A single button shall be furnished at each terminal and up down buttons at all intermediate landings. Button plates shall be flush mount and shall be large enough to cover holes left by existing plates. Use 100,000-hour life LED type indicators. Buttons shall be stainless steel vandal resistant. Hall plate to be engraved with ANSI fire service operation details.

Q. Terminal limit switches: Terminal limit switches shall be provided in the hoistway designed to automatically stop the car at each terminal landings.

R. Car position indicator: An digital position indicator shall be provided in the car and on the egress level landing, directly over the entrance or incorporated in the egress floor hall station. Floor arrival and passing gong as well as direction indication shall be incorporated in position indicator.

S. Car guide rails: Designed to span from floor to floor without intermediate supports.

T. Car guide shoes: The top and bottom of the car frames shall be provided with new roller guide shoes type of adequate design to sustain the loads imposed.

U. New Speed governors and tail sheaves: A car speed-governor conforming to the requirements of ASMI A17.1, Section 206 shall be provided to activate the car safety.

V. Hoistway Entrances: New entrances shall be stainless steel to match new stainless steel hoistway doors.

W. Car safety: A car safety shall be provided which will conform to the requirements of ANSI A17.1, Section 205. The safety shall be of the type, which can be released only by moving the car in the up direction. To return a car to normal operation after a safety set.

X. Hoistway Doors: New hoistway doors shall be provided with cutouts and reinforcements at door equipment bolt locations, emergency door access holes shall include escutcheons.

Y. Elevator two-way communications system: Provide and install a two-way communication system to comply with ANSI ASME A17.1 section 2.27. Furnish and install a "hands free" two-way conversation analog telephone system between the elevator car and a location in the building that is readily accessible by emergency personnel. An additional means of communication must be provided between the elevator and University Police Services headquarters. A separate means of two-way conversation must be provided in the elevator machine room for communication to the elevator car.

1. Provide and install an analog ADA compliant, hands-free indoor emergency phone, flush mounted with AUX inputs/outputs and voice location identifier
   a. Suggested manufacturer and model: Talk-A-Phone; ETP-100EBV"AUX" phone

2. Furnish and install a two-way conversation telephone system between the elevator car and a location in the “egress floor level lobby” that is easily accessible by emergency personnel. The telephone must be housed in a steel “Best” key core lockable cabinet. The cabinet must protrude no more than 4” into the pedestrian corridor as per ICC/ANSI A117.1-1998.
   a. Suggested stainless Steel box manufacturer and model: Talk-A-Phone; ETP-SMB/PSU
   b. Suggested telephone manufacturer and model: Talk-A-Phone; 68429 analog panel mount phone

3. Furnish and install a two-way conversation telephone system between the elevator car and the elevator machine room.
a. Suggested manufacturer and model:
   Talk-A-Phone; 68429 analog panel mount phone

4. Additional components: provide and install all necessary peripheral components to complete
   the elevator two-way communications system.
   a. a. provide and install an analog telephone line consolidator in the elevator machine
      room that will connect the analog phone lines going to the elevator car, “lobby” phone,
      and the “machine room” phone.
      1) Suggested manufacturer and model:
         Talk-A-Phone “EC-8” 8 Channel Consolidator

b. Raceways between elevator machine room controller and “Lobby” phone location:
   (Existing Construction):
   1) All raceways installed between the elevator controller and lobby phone shall be
      concealed within the existing building construction where possible. Walls shall
      be “fished” using a ¾” flexible metal conduit from ceiling to the location of the
      phone device box. Raceways above ceilings shall be concealed where
      suspended ceilings are existing, using ¾” EMT conduit with compression type
      fittings. Where concealment above ceilings is not possible, raceways shall
      be surface mounted and painted to match surrounding finishes, routed in a neat
      inconspicuous manner. Raceways shall be installed in accordance with the 2002
      National Electrical Code.

c. Telephone device boxes:
   1) Contractor shall coordinate final device box requirements with University based
      on phone type selected. Contractor shall provide a single gang device box flush
      mounted in wall at a height as directed by the University at final location of the
      lobby phone.

Z. Flashing Fire Sign: Back lit flashing signs matching other elevator fixtures to alert waiting
   passengers that the elevators have been taken out service due to an emergency.

AA. Keys: Upon the initial acceptance of work specified by the Contract Documents on the unit
   of vertical transportation equipment, the contractor shall deliver to the owner, four (4) keys for each
   new key-operated device that is provided. NOTE: All key operated devices should be “best” core
   compatible.

BB. Furnish and install deflector sheave guards on all deflector sheaves.

CC. Hoistway door jamb plates shall be installed on the door frames of each landing. Plates shall have
   numerical floor designation and Braille markings as per ADA requirements.

DD. Smoke Sensors: Tie into existing smart alarm system. It shall be the elevator contractor's
   responsibility to have the smoke and alarm system readdressed as required. Smoke sensors are to
   be located within ten (10) feet of the elevator entrance at each floor. Provide and install a smoke
   sensor in the machine room. Upon activation of any sensor, the elevator shall return to the egress
   floor level on fireman’s recall as per code. Upon activation of the egress landing smoke sensor,
   elevator shall recall to an alternate floor. Provide alarm and contacts for connection to building fire
   alarm system.

EE. Provide control wiring to the smoke damper as shown on mechanical drawings. Smoke damper
   provided and installed by mechanical contractor.

FF. Provide quilted car pads in all cars fitted to protect the interior finish of each car.

GG. Counterweight Guides: New counterweight guides with new roller guides.

HH. Emergency stop switches: Provide new emergency stop switches in the hoistway. One pushbutton
    switch is to be located in the pit and is to be accessible from the door entering the pit. The other
    pushbutton switch is to be located in the machine space accessible from the over-speed governor.
II. Ascending car overspeed and unintended car movement protection: A device shall be provided to prevent the car from striking the hoistway overhead structure. Electrical power failure or mechanically operated switch failure shall not render the device inoperative. Once actuated, the device shall remain actuated until manually reset. A device shall be provided to prevent unintended car movement away from the landing when the hoistway door and car door are open.

JJ. Access Door: Provide 24” x 24” fire rated access door to allow access to rear side of motor, if required based on final configuration and orientation of elevator. Provide non-combustible fixed ladder meeting ANSI A14.3 to reach access door.

2.4 FINISH MATERIALS

A. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.

B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.

C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.

D. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.

E. Stainless-Steel Bars: ASTM A 276, Type 304.

F. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.

G. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063.


I. Phelolic Panel: See Division 6 Section "Interior Architectural Millwork" for phenolic panel information.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Examine hoistways, hoistway openings, pits, and machine rooms as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions.

B. Coordinate work with building occupants.
C. Provide construction signs during work times.

D. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.

E. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.

F. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.

G. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

H. Leveling Tolerance: 1/8 inch (3 mm), up or down, regardless of load and travel direction.

I. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.

J. Locate hall signal equipment for elevators as follows unless otherwise indicated:
   1. Place hall lanterns either above or beside each hoistway entrance.
   2. Mount hall lanterns at a minimum of 72 inches (1829 mm) above finished floor.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.

B. Tests to include full load safety test and empty car safety test. Adjust car leveling upon each test.

C. Prior to end of 12-month maintenance period, contractor will again perform full load safety test and empty car safety test. Adjust car leveling upon each test.

D. Operating Test: Load elevator to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. Record temperature rise of elevator machine during 30-minute test period. Record failure to perform as required.

E. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators. A minimum of 48 hours notice is required prior to the elevator inspection and testing of any elevator systems.

F. Contractor is to provide the University with the initial inspection certificate and a copy of the initial inspection report.

3.4 PROTECTION

A. Temporary Use: Comply with the following requirements for elevator used for construction purposes:
1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
2. Provide strippable protective film on entrance and car doors and frames.
3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
5. Do not load elevators beyond their rated weight capacity.
6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

B. Provide final protection and maintain conditions, in a manner acceptable to elevator manufacturer and installer that ensure elevators are without damage or deterioration at the time of Substantial Completion.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator(s). Contractor shall instruct the University’s personnel in proper use, operation, and daily maintenance of elevators. Review emergency provisions and train Owner's personnel in procedures to follow in identifying sources of operational failures or malfunctions.

B. Check operation of each elevator with Owner's personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

3.6 RECORD DOCUMENTS

A. Provide the University with (2) hard copies and (2) electronic copy on disc of “As Built” adjustments reflecting setup after final adjustments are made. Include all wiring numbering and labeling, and any changes made from the original design documents. Drawings are to be laminated both sides for protection. Prints to be hole punched and bound with two metal rings in flip chart fashion. Contractor to provide a metal cabinet to store the as built drawings in the elevator machine room. Cabinet to be Grainger #1ufc1 36”x 30’x 18”.

3.7 WASTE MANAGEMENT

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
   1. Aluminum
   2. Plastic Materials and Gaskets
   3. Corrugated cardboard packaging.

C. Separate the following categories for disposal and place in designated areas for hazardous materials:
1. Treated, stained, painted or contaminated wood.

D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

END OF SECTION 14 20 00
HENDERSON ADDITION
BIOBEHAVIORAL HEALTH BUILDING
College of Health and Human Development
The Pennsylvania State University
University Park, PA

Project Specifications

12 November 2010

Volume 3
Divisions 15 - 33

Bohlin Cywinski Jackson
Architecture Planning Interiors

DGS 800-290  BCJ Project No. 08001  PSU Project No. 06-42744.00
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SECTION 21 05 17 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Sleeves.
   2. Stack-sleeve fittings.
   3. Sleeve-seal systems.

PART 2 - PRODUCTS

2.1 SLEEVES
A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends. (For exterior walls.)
B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint. (For interior use only.)
C. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.
2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Advance Products & Systems, Inc.
2. Metraflex Company (The).
3. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Plastic.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 GROUT


B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.
   1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
   3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
   4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

END OF SECTION 21 05 17
SECTION 21 05 18 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Escutcheons.
   2. Floor plates.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.
B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.
E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with rough-brass finish.
   f. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with rough-brass finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 21 0518
SECTION 21 12 00 - FIRE-SUPPRESSION STANDPIPES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Pipes, fittings, and specialties.
   2. Fire-protection valves.
   3. Hose connections.
   4. Monitors.
   5. Fire-department connections.
   6. Alarm devices.
   7. Pressure gages.

B. Related Sections:
   1. Division 21 Section "Wet-Pipe Sprinkler Systems" for wet-pipe sprinkler piping.
   2. Division 28 Section "Digital, Addressable Fire-Alarm System" for alarm devices not specified in this Section.

1.3 DEFINITIONS

A. Standard-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure 175 psig maximum.

1.4 SYSTEM DESCRIPTIONS

A. Manual Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Has small water supply to maintain water in standpipes. Piping is wet, but water must be pumped into standpipes to satisfy demand.

1.5 PERFORMANCE REQUIREMENTS

A. Standard-Pressure, Fire-Suppression Standpipe System Component: Listed for 175-psig minimum working pressure.

B. Delegated Design: Design fire-suppression standpipes, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
1. Available fire-hydrant flow test data is available on the Fire Protection drawings cover sheet. Water pressure available is adequate to supply all sprinklers through-out the building. The Fire Department will need to utilize a pumper truck to provide adequate pressure for the upper-floor hose-connections.

C. Fire-suppression standpipe design shall be approved by authorities having jurisdiction.

1. Minimum residual pressure at each hose-connection outlet is as follows:
   a. NPS 2-1/2 Hose Connections: 100 psig.

2. Maximum residual pressure at required flow at each hose-connection outlet is as follows unless otherwise indicated:
   a. NPS 2-1/2 Hose Connections: 175 psig.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For fire-suppression standpipes. Include plans, elevations, sections, details, and attachments to other work.

   1. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For standpipe systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Fire-suppression standpipes, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

   1. Domestic water piping.
   2. Compressed air piping.
   3. HVAC hydronic piping.
   4. HVAC ductwork.
   5. Electrical and data wire tray assemblies.

B. Qualification Data: For qualified Installer and professional engineer.

C. Approved Standpipe Drawings: Working plans, prepared according to NFPA 14, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

D. Welding certificates.

F. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-suppression standpipes specialties to include in emergency, operation, and maintenance manuals.

1.9 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing fire-suppression standpipes and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

   a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14, "Installation of Standpipe and Hose Systems."

1.10 PROJECT CONDITIONS

A. Interruption of Existing Campus Water Service: The fire-suppression system shall be served by a combined fire-suppression/domestic water service entrance. Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

   1. Notify Construction Manager no fewer than two days in advance of proposed interruption of fire-suppression standpipe service.
   2. Do not proceed with interruption of fire-suppression standpipe service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS
A. Standard Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 30, Galvanized- and Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.

C. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.


E. Galvanized, Steel Couplings: ASTM A 865, threaded.


G. Malleable- or Ductile-Iron Unions: UL 860.


I. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.


K. Grooved-Joint, Steel-Pipe Appurtenances:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Tyco Fire & Building Products LP.
      b. Victaulic Company.
   2. Pressure Rating: 175 psig minimum.
   4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
   1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
   2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 LISTED FIRE-PROTECTION VALVES

A. General Requirements:
   1. Valves shall be UL listed or FM approved.

B. Ball Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Anvil International, Inc.
      b. Victaulic Company.
   2. Standard: UL 1091 except with ball instead of disc.
   3. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
   4. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
   5. Valves NPS 3: Ductile-iron body with grooved ends.

C. Iron Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Anvil International, Inc.
      b. Kennedy Valve; a division of McWane, Inc.
      c. NIBCO INC.
      d. Tyco Fire & Building Products LP.
      e. Victaulic Company.
   2. Standard: UL 1091.
   4. Body Material: Cast or ductile iron.
   5. Style: Lug or wafer.

D. Check Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. Kennedy Valve; a division of McWane, Inc.
c. NIBCO INC.
d. Potter Roemer.
e. Reliable Automatic Sprinkler Co., Inc.
f. Tyco Fire & Building Products LP.
g. Victaulic Company.
h. Viking Corporation.

4. Type: Swing check.
5. Body Material: Cast iron.
6. End Connections: Flanged or grooved.

E. Iron OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. NIBCO INC.
   b. Tyco Fire & Building Products LP.
   c. Watts Water Technologies, Inc.

4. Body Material: Cast or ductile iron.
5. End Connections: Flanged or grooved.

2.5 TRIM AND DRAIN VALVES

A. General Requirements:

2. Pressure Rating: 175 psig minimum.

B. Angle Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Fire Protection Products, Inc.
   b. United Brass Works, Inc.

C. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Fire-End & Croker Corporation.
   c. Kennedy Valve; a division of McWane, Inc.
d. NIBCO INC.
e. Potter Roemer.
f. Tyco Fire & Building Products LP.
g. Victaulic Company.

D. Globe Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers
      offering products that may be incorporated into the Work include, but are not limited to,
      the following:
         a. Fire Protection Products, Inc.
         b. United Brass Works, Inc.

2.6 SPECIALTY VALVES

A. General Requirements:
      published by FM Global, listing.
   2. Pressure Rating:
      a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
   3. Body Material: Cast or ductile iron.
   4. Size: Same as connected piping.
   5. End Connections: Flanged or grooved.

B. Alarm Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers
      offering products that may be incorporated into the Work include, but are not limited to,
      the following:
      a. Reliable Automatic Sprinkler Co., Inc.
      b. Tyco Fire & Building Products LP.
      c. Victaulic Company.
      d. Viking Corporation.
   3. Design: For horizontal or vertical installation.
   4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and
      fill-line attachment with strainer.
   5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
   6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Automatic (Ball Drip) Drain Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers
      offering products that may be incorporated into the Work include, but are not limited to,
      the following:
      a. Reliable Automatic Sprinkler Co., Inc.
      b. Tyco Fire & Building Products LP.
4. Type: Automatic draining, ball check.

2.7 HOSE CONNECTIONS

A. Nonadjustable-Valve Hose Connections:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Fire-End & Croker Corporation.
   c. NIBCO INC.
   d. Potter Roemer.
   e. Tyco Fire & Building Products LP.

2. Standard: UL 668 hose valve for connecting fire hose.
3. Pressure Rating: 300 psig minimum.
4. Material: Brass or bronze.
5. Size: NPS 1-1/2 or NPS 2-1/2, as indicated.
6. Inlet: Female pipe threads.
7. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
8. Pattern: Angle or gate.

2.8 MONITORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Fire-End & Croker Corporation.
3. Potter Roemer.

B. Type: Stationary.

C. Nozzle: UL 401, NPS 2-1/2, brass, adjustable from fog spray to straight stream to shutoff.

D. Horizontal Rotation: 360 degrees with locking device.

E. Vertical Rotation: 80-degree elevation and 60-degree depression with locking device.

F. Waterway: Double brass or stainless-steel tube.

G. Waterway Size: NPS 2-1/2 minimum.

I. Operation: Lever.

J. Base Inlet Size: NPS 2-1/2.

K. Finish: Red-painted body with brass trim.

2.9 FIRE-DEPARTMENT CONNECTIONS

A. Yard-Type, Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   
   
   b. Fire-End & Croker Corporation.


3. Type: Exposed, freestanding.


6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

7. Caps: Brass, lugged type, with gasket and chain.


10. Number of Inlets: Two.


12. Sleeve Height: 18 inches.

13. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."


2.10 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections. Refer to Division 28 Section “Digital, Addressable Fire-Alarm System.”

B. Water-Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:


   b. Potter Electric Signal Company.

   c. Viking Corporation.


4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-
adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
7. Design Installation: Horizontal or vertical.

C. Pressure Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Tyco Fire & Building Products LP.
   c. Viking Corporation.

3. Type: Electrically supervised water-flow switch with retard feature.
5. Design Operation: Rising pressure signals water flow.

D. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Kennedy Valve; a division of McWane, Inc.
   b. Potter Electric Signal Company.

3. Type: Electrically supervised.
5. Design: Signals that controlled valve is in other than fully open position.

2.11 PRESSURE GAGES

A. Basis-of-Design is "Quality" series gage as manufactured by Marsh Instrument Company. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AMETEK; U.S. Gauge Division.
2. Ashcroft Inc.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gage Range: 0 to 250 psig minimum.

E. Water System Piping Gage: Include "WATER" label on dial face.

PART 3 - EXECUTION
3.1 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression (standpipe and sprinkler) piping to combined fire-suppression/domestic water water-service piping at service entrance into building.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories at connection to fire-suppression water-service piping.

3.3 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements in NFPA 14 for installation of fire-suppression standpipe piping.

C. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install drain valves on standpipes. Extend drain piping to outside of building.

E. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or outside building.

F. Install alarm devices in piping systems.

G. Install hangers and supports for standpipe system piping according to NFPA 14. Comply with requirements in NFPA 13 for hanger materials.

H. Install pressure gages on riser or feed main and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

I. Fill wet-type standpipe system piping with water.

J. Install sleeves for piping penetrations of walls, ceilings, and floors.
K. Install sleeve seals for piping penetrations of concrete walls and slabs.

L. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.4 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system’s pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

I. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to “Quality Assurance” Article.
   1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

3.5 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 14 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
D. Specialty Valves:
   1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

3.6 HOSE-CONNECTION INSTALLATION
A. Install hose connections adjacent to standpipes.
B. Install freestanding hose connections for access and minimum passage restriction.
C. Install NPS 2-1/2 hose-connection valves with NPS 1-1/2 threaded reducers and chained caps.
D. Install NPS 2-1/2 hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 reducer adapter and flow-restricting device.
E. Install wall-mounted-type hose connections in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Division 10 Section "Fire Extinguisher Cabinets."

3.7 MONITOR INSTALLATION
A. Install monitors on standpipe piping.

3.8 FIRE-DEPARTMENT CONNECTION INSTALLATION
A. Install wall-type, fire-department connections.
B. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in Division 03 Section "Cast-in-Place Concrete."
   1. Install three protective pipe bollards around each fire-department connection. Comply with requirements for bollards in Division 05 Section "Metal Fabrications."
C. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.9 IDENTIFICATION
A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 14.
B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
C. Fire protection piping shall be painted red (Rust-Oleum #1210, or approved equal). Refer to Division 09 Section "Interior Painting."

3.10 FIELD QUALITY CONTROL
A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Verify that equipment hose threads are same as local fire-department equipment.

C. Fire-suppression standpipe system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 PIPING SCHEDULE

A. Piping from water main, through the combined service entrance to the backflow preventer: Black-steel, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded joints.

B. Standard-pressure, wet-type, fire-suppression standpipe piping, shall be one of the following:

1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight or Schedule 30, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
4. Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
5. Schedule 10, black-steel pipe with plain ends; welding fittings; and welded joints.

C. Standard-pressure, piping subject to alternate wetting and drying (drain piping, test piping, Siamese connections between the Siamese shall be and check valves wet-type, fire-suppression standpipe piping, shall be the following:

1. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints, and properly sloped to completely drain.

END OF SECTION 21 12 00
SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS [C]

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Fire-department connections.
4. Sprinklers.
5. Alarm devices.
7. Control panels.
8. Pressure gages.

B. Related Sections:

1. Division 21 Section "Fire-Suppression Standpipes" for standpipe piping.
2. Division 28 Section "Digital, Addressable Fire-Alarm System" for alarm devices not specified in this Section.

1.3 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.4 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.5 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
C. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.

2. Sprinkler Occupancy Hazard Classifications:
   a. Building Service Areas: Ordinary Hazard, Group 1.
   b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
   c. General Storage Areas: Ordinary Hazard, Group 1.
   d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
   e. Office and Public Areas: Light Hazard.

3. Minimum Density for Automatic-Sprinkler Piping Design:
   a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
   b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.

4. Maximum Protection Area per Sprinkler: Per UL listing.
5. Maximum Protection Area per Sprinkler:
   a. Office Spaces: 225 sq. ft.
   b. Storage Areas: 130 sq. ft.
   c. Mechanical Equipment Rooms: 130 sq. ft.
   d. Electrical Equipment Rooms: 130 sq. ft.
   e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

6. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
   a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
   b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.

1.6 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Color Selection Charts: Provide full custom color palette for Architect to select colors for concealed head covers. Colors shall be factory applied.
C. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.
D. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Domestic water piping.
2. Compressed air piping.
3. HVAC hydronic piping.
4. HVAC ductwork.
5. Electrical and data wire tray assemblies.
6. Items penetrating finished ceiling include the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Ceiling mounted A/V equipment.

B. Qualification Data: For qualified Installer and professional engineer.

C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

D. Welding certificates.

E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

F. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.9 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13, "Installation of Sprinkler Systems."

1.10 PROJECT CONDITIONS
A. Interruption of Existing Campus Water Service: The fire-suppression system shall be served by a combined fire-suppression/domestic water service entrance. Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of fire-suppression standpipe service.
2. Do not proceed with interruption of fire-suppression standpipe service without Construction Manager's written permission.

1.11 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

A. Standard Weight, Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.


2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.

1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 LISTED FIRE-PROTECTION VALVES

A. General Requirements:
1. Valves shall be UL listed or FM approved.

B. Ball Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Anvil International, Inc.
   b. Victaulic Company.
2. Standard: UL 1091 except with ball instead of disc.
3. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
4. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
5. Valves NPS 3: Ductile-iron body with grooved ends.

2.5 TRIM AND DRAIN VALVES

A. General Requirements:
2. Pressure Rating: 175 psig minimum.

B. Angle Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Fire Protection Products, Inc.
   b. United Brass Works, Inc.

2.6 SPECIALTY VALVES

A. General Requirements:
2. Pressure Rating:
   a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
   b. High-Pressure Piping Specialty Valves: 250 psig minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Victaulic Company.

3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.
5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

2.7 FIRE-DEPARTMENT CONNECTIONS

A. Yard-Type, Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

3. Type: Exposed, freestanding.
6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lug swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
10. Number of Inlets: Two.
12. Sleeve Height: 18 inches.
13. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."

2.8 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Tyco Fire & Building Products LP.
   b. Victaulic Company.

4. **Body Material:** Ductile-iron housing with EPDM seals and bolts and nuts.

5. **Type:** Mechanical-T and -cross fittings.

6. **Configurations:** Snap-on and strapless, ductile-iron housing with branch outlets.

7. **Size:** Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.

8. **Branch Outlets:** Grooved, plain-end pipe, or threaded.

**B. Flow Detection and Test Assemblies:**

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Reliable Automatic Sprinkler Co., Inc.
   b. Tyco Fire & Building Products LP.
   c. Victaulic Company.


3. **Pressure Rating:** 175 psig minimum.

4. **Body Material:** Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.

5. **Size:** Same as connected piping.

6. **Inlet and Outlet:** Threaded.

**C. Branch Line Testers:**

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   b. Fire-End & Croker Corporation.
   c. Potter Roemer.

2. **Standard:** UL 199.

3. **Pressure Rating:** 175 psig.

4. **Body Material:** Brass.

5. **Size:** Same as connected piping.

6. **Inlet:** Threaded.

7. **Drain Outlet:** Threaded and capped.

8. **Branch Outlet:** Threaded, for sprinkler.

**D. Sprinkler Inspector’s Test Fittings:**

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Tyco Fire & Building Products LP.
   b. Victaulic Company.
   c. Viking Corporation.

4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

2.9 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire & Building Products LP.

B. General Requirements:

4. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

2. Nonresidential Applications: UL 199.
3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Finishes:

1. Chrome plated.
2. Bronze.
3. Painted.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

F. Sprinkler Guards:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Tyco Fire & Building Products LP.  
b. Victaulic Company.  
c. Viking Corporation.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.10 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections. Refer to Division 28 Section “Digital, Addressable Fire-Alarm System.”

2.11 PRESSURE GAGES

A. Basis-of-Design is “Quality” type gage as manufactured by Marsh Instrument Company. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AMETEK; U.S. Gauge Division.
2. Ashcroft Inc.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gage Range: 0 to 250 psig minimum.

E. Water System Piping Gage: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression (standpipe and sprinkler) piping to combined fire-suppression/domestic water water-service piping at service entrance into building.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories at connection to fire-suppression water-service piping.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller.
E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

J. Install alarm devices in piping systems.

K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

M. Fill sprinkler system piping with water.

N. Install sleeves for piping penetrations of walls, ceilings, and floors.

O. Install sleeve seals for piping penetrations of concrete walls and slabs.

P. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

I. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to “Quality Assurance” Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

J. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

K. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

L. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

3.5 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.6 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in Division 03 Section "Cast-in-Place Concrete."

1. Install three protective pipe bollards around each fire-department connection. Comply with requirements for bollards in Division 05 Section "Metal Fabrications."

B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.7 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Fire protection piping shall be painted red (Rust-Oleum #1210, or approved equal). Refer to Division 09 Section "Interior Painting."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.
3.10 PIPING SCHEDULE

A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

B. Piping from water main, through the combined service entrance to the backflow preventer: Black-steel, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded joints.

C. Standard-pressure, wet-type, fire-suppression standpipe piping, shall be one of the following:

   1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. Standard-weight or Schedule 30, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   3. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   4. Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   5. Schedule 10, black-steel pipe with plain ends; welding fittings; and welded joints.

D. Standard-pressure, piping subject to alternate wetting and drying (drain piping, test piping, Siamese connections between the Siamese shall be) and check valves wet-type, fire-suppression standpipe piping, shall be the following:

   1. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints, and properly sloped to completely drain.

3.11 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

   1. Rooms without Ceilings: Upright sprinklers.
   2. Rooms with Suspended Ceilings: Concealed sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

   1. Concealed Sprinklers: Rough brass, with factory-painted custom factory colored cover plate.
   2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
   3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
   4. Residential Sprinklers: Dull chrome.
   5. Upright Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 13 13
SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION
A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS
A. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.
B. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS
A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:
   1. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
   5. Shaft Grounding: Mercotac electrical slip rings or Aegis grounding rings to be installed by motor or equipment manufacturer or installed in the field by contractor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 22 05 13
SECTION 22 05 16 - EXPANSION LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Pipe loops and swing connections.
   2. Alignment guides and anchors.

1.3 PERFORMANCE REQUIREMENTS
A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

PART 2 - PRODUCTS

2.1 ALIGNMENT GUIDES AND ANCHORS
A. Alignment Guides:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Flex-Hose Co., Inc.
      b. Metraflex, Inc.
   2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.
B. Anchor Materials:
   1. Steel Shapes and Plates: ASTM A 36/A 36M.
   2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
   4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

PART 3 - EXECUTION

3.1 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.
B. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.
C. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.2 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
C. Attach guides to pipe and secure guides to building structure.
D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
E. Anchor Attachments:
   2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
   1. Anchor Attachment to Steel Structural Members: Attach by welding.
   2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 22 05 16
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Sleeves.
   2. Stack-sleeve fittings.
   3. Sleeve-seal systems.

PART 2 - PRODUCTS

2.1 SLEEVES
A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends. (For exterior walls.)
B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint. (For interior use only.)
C. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.
2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Advance Products & Systems, Inc.
2. Metraflex Company (The).
3. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Plastic.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 GROUT


B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.
   1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
   3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
   4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

END OF SECTION 22 05 17
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SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Escutcheons.
      2. Floor plates.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS
   A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and
      setscrew fastener.
   B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and
      spring-clip fasteners.
   C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
   D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with
      concealed hinge and setscrew.
   E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet
      hinge, and spring-clip fasteners.

2.2 FLOOR PLATES
   A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
   B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with rough-brass finish.
   f. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with rough-brass finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

   1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 22 05 18
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Liquid-in-glass thermometers.
      2. Dial-type pressure gages.
      4. Test plugs.
   B. Related Sections:
      1. Division 21 fire-suppression piping Sections for fire-protection pressure gages.
      2. Division 22 Section "Domestic Water Piping" for water meters inside the building.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS
   A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS
   A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
      1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
3. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Basis-of-Design is "Quality" series gage as manufactured by Marsh Instrument Company. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. AMETEK, Inc.; U.S. Gauge.
   b. Trerice, H. O. Co.
   c. Weiss Instruments, Inc.

3. Case: Liquid-filled type(s); Stainless steel; 4-1/2-inch nominal diameter, except for in mechanical spaces which shall utilize 6-inch nominal diameter on steam and condensate systems.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.3 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with NPS 1/2, ASME B1.20.1 pipe threads.
2.4 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Miljoco Corporation.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: EPDM self-sealing rubber.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

B. Install valve and snubber in piping for each pressure gage for fluids.

C. Install test plugs in piping tees.

D. Install thermometers in the following locations:

1. Inlets and outlets of each domestic water heat exchanger.
2. Cold water and hot water inlets, and hot water outlets of each mixing valve.

E. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Suction and discharge of each domestic water pump.
3. Inlet and outlet of make-up water pressure reducing valves (e.g. heating hot water make-up).
4. Compressed air service entrance to Bridge Building.
5. Compressed air at each load.
6. Air compressor discharge at new air compressor in Henderson North.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
3.3 ADJUSTING
A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE
A. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:
   1. Industrial-style, liquid-in-glass type.
   2. and Test plug with EPDM self-sealing rubber inserts.
B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE
A. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F.

3.6 PRESSURE-GAGE SCHEDULE
A. Pressure gages at discharge of each water service into building shall be the following:
   1. Liquid-filled, direct-mounted, metal case.
   2. and Test plug with EPDM self-sealing rubber inserts.
B. Pressure gages at suction and discharge of each domestic water pump shall be[ one of] the following:
   1. Liquid-filled, direct-mounted, metal case.
   2. and Test plug with EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE
A. Scale Range for Water Service Piping: 0 to 160 psi.
B. Scale Range for Domestic Water Piping: 0 to 160 psi.
C. Scale Range for Compressed Air Piping: 0 to 160 psi.

END OF SECTION 22 05 19
SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following general-duty valves:
   1. Bronze ball valves.
   2. Iron ball valves.
   4. Iron swing check valves.
   5. Bronze gate valves.
   7. Bronze globe valves.
   8. Iron globe valves.

B. Related Sections include the following:
   1. Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.
   2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and charts.
   3. Division 22 piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS
A. The following are standard abbreviations for valves:
   1. CWP: Cold working pressure.
   2. PTFE: Polytetrafluoroethylene plastic.
   3. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS
A. All valves for this project shall be from one manufacturer. Multiple manufacturers are listed to provide the contractor with the ability to competitively price the project, but is not to allow the contractor to use more than one manufacturer on the project.

B. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
1.5 QUALITY ASSURANCE

A. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

B. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. All valves for this project shall be from one manufacturer. Multiple manufacturers are listed to provide the contractor with the ability to competitively price the project, but is not to allow the contractor to use more than one manufacturer on the project.

B. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.

C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.
D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:
   1. Handwheel: For valves other than quarter-turn types.
   2. Lever Handle: For quarter-turn valves NPS 6 and smaller.

G. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   1. Gate Valves: With rising stem.
   2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

H. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Solder Joint: With sockets according to ASME B16.18.
   3. Threaded: With threads according to ASME B1.20.1

I. Valve Bypass and Drain Connections: MSS SP-45.

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
   1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. NIBCO INC.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Two piece.
      e. Body Material: Bronze.
      f. Ends: Threaded.
      g. Seats: PTFE or TFE.
      h. Stem: Stainless steel.
      i. Ball: Stainless steel, vented.
      j. Port: Full.

2.4 IRON BALL VALVES

A. Class 125, Iron Ball Valves:
1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   b. CWP Rating: 200 psig.
   d. Body Material: ASTM A 126, gray iron.
   e. Ends: Flanged.
   f. Seats: PTFE or TFE.
   g. Stem: Stainless steel.
   h. Ball: Stainless steel.
   i. Port: Full.

2.5  **BRONZE SWING CHECK VALVES**

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 200 psig.
   c. Body Design: Horizontal flow.
   e. Ends: Threaded.
   f. Disc: Bronze.

2.6  **IRON SWING CHECK VALVES**

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-71, Type I.
   b. CWP Rating: 200 psig.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.
   g. Gasket: Asbestos free.

2.7 BRONZE GATE VALVES

A. Class 125, RS Bronze Gate Valves:
   1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. NIBCO INC.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig.
   d. Ends: Threaded or solder joint.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron, bronze, or aluminum.

2.8 IRON GATE VALVES

A. Class 125, OS&Y, Iron Gate Valves:
   1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. NIBCO INC.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-70, Type I.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM A 126, gray iron with bolted bonnet.
   d. Ends: Flanged.
   e. Trim: Bronze.
   f. Disc: Solid wedge.
2.9 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   d. Ends: Threaded or solder joint.
   e. Stem and Disc: Bronze.
   f. Packing: Asbestos free.
   g. Handwheel: Malleable iron, bronze, or aluminum.

2.10 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:

1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-85, Type I.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM A 126, gray iron with bolted bonnet.
   d. Ends: Flanged.
   e. Trim: Bronze.
   f. Packing and Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball valves shall be the primary type. Large line sizes may use gate valves.
2. Throttling Service: Globes valves shall be the primary type, but ball valves with characterizing discs may be used.
3. Pump Discharge: Bronze swing check valves with bronze or nonmetallic disc. Triple duty valves shall not be used.

B. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.

C. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.3 Low-Pressure, Compressed-Air Piping:

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, brass with stainless-steel trim.
3. Bronze Swing Check Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:
1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves: Class 125, metal seats.
3. Iron Gate Valves: Class 125, OS&Y.

3.4 Domestic Water Piping:

A. Pipe NPS 2 and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: Two piece, full port, brass with stainless-steel trim.
   3. Bronze Swing Check Valves: Class 125, bronze disc.
   4. Bronze Gate Valves: Class 125, RS.
   5. Bronze Globe Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
   2. Iron Ball Valves: Class 125.
   3. Iron Swing Check Valves: Class 125, metal seats.
   4. Iron Gate Valves: Class 125, OS&Y.

3.5 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves with bonnet in an upright position to minimize deterioration and corrosion of the bonnet and packing.

F. Install valves in position to allow full stem movement.

G. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.

3.6 JOINT CONSTRUCTION

A. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.7 ADJUSTING
A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 22 05 23
SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe positioning systems.
   7. Equipment supports.

1.3 DEFINITIONS
A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS
A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
   1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.
   c. Flex-Strut Inc.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut Corporation; Tyco International, Ltd.
   g. Wesanco, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carpenter & Paterson, Inc.
3. ERICO International Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.


I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and within 12-inches of changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.
3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 6, requiring clamp flexibility and up to 4 inches of insulation.
   3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 6 if little or no insulation is required.
   4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 6.
6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 6.
7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 6.
8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 6.
9. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 6.
11. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
12. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 6, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
13. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 6, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
14. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 6 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
15. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 6, from two rods if longitudinal movement caused by expansion and contraction might occur.
16. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 6, from single rod if horizontal movement caused by expansion and contraction might occur.
17. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 2 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
18. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
19. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 6 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 6.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 6 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
   b. Medium (MSS Type 32): 1500 lb.
   c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

Q. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.
R. No holes shall be burned or drilled in structural steel for hanger rod supports.

END OF SECTION 22 05 29
SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Pipe labels.
   3. Valve tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
C. Valve numbering scheme.
D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
B. Coordinate installation of identifying devices with locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Black micarta laminate, and having predrilled or stamped holes for attachment hardware.
   2. Minimum Label Size: Length and width vary for required label content, but not less than 2 by 1 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.


B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Self-Adhesive Pipe Labels: Printed vinyl-backed cloth with contact-type, permanent-adhesive backing.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: 1-inch x 2-inch black micarta laminated tags, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: 10-gauge Brass S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag, and in accordance with design drawing abbreviations), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2. Valve schedule shall be mounted in a glass-front frame.

PART 3 - EXECUTION
3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of paint, identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 PIPE AND EQUIPMENT COLOR CODING

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting." Paint the piping as indicated below:

1. Compressed air: Yellow with green band.
2. Potable Water: Green.
5. Drain lines: Aluminum with red bands.

B. Equipment Color-Coding:
1. Air tanks (compressed): Yellow with green band.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

C. For equipment in finished areas the equipment tags shall be located inside an access door.

3.4 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 15 feet along each run.

B. Pipe Label Color Schedule:

1. Low-Pressure, Compressed-Air Piping:
   a. Background Color: Yellow.
   b. Letter Color: Black.
2. Domestic Water Piping:
   a. Background Color: Green.
   b. Letter Color: Black.

3. Sanitary Waste and Storm Drainage Piping:
   b. Letter Color: Black.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag all valves as indicated below:

1. Valve-Tag Size and Shape: 1 inch x 2 inch
2. Valve-Tag Color: Black
3. Letter Color: White

END OF SECTION 220553
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes insulating the following plumbing piping services:
   1. Domestic cold-water piping.
   2. Domestic hot-water piping.
   3. Domestic recirculating hot-water piping.
   4. Roof drains and rainwater leaders.
   5. Supplies and drains for handicap-accessible lavatories and sinks.
   6. Domestic hot water steam-to-hot water generator.
   7. Domestic recirculating hot water pump.
B. Related Sections:
   1. Division 22 Section "Identification for Plumbing Piping and Equipment" for color coded painting requirements of the systems.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.

1.4 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

1.5 QUALITY ASSURANCE
A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having
jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:


1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Equipment Insulation" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; SOFTR All-Service Duct Wrap.

G. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000-Degree Pipe Insulation.
   d. Manson Insulation Inc.; Alley-K.
   e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   
   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

### 2.3 MASTICS

**A.** Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

**B.** Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   
   b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

**C.** Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   
   b. Eagle Bridges - Marathon Industries; 550.
   e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
2.4 SEALANTS

A. Joint Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Service Temperature Range: Minus 100 to plus 300 deg F.
   3. Color: White or gray.
   4. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. ABI, Ideal Tape Division; 428 AWF ASJ.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      c. Compac Corporation; 104 and 105.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.7 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping and Seals.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2.8 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.
H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above-ambient services, do not install insulation to the following:
   1. Testing agency labels and stamps.
   2. Nameplates and data plates.
   3. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

D. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe, and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
   a. Do not weld anchor pins to ASME-labeled pressure vessels.
   b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
   c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
   d. Do not overcompress insulation during installation.
   e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
   f. Impale insulation over anchor pins and attach speed washers.
   g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
   1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
   2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:
   1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
   2. Fabricate boxes from galvanized steel, at least 0.040 inch thick.
   3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.


B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as indicated in Division 22 Section “Plumbing Piping and Equipment Identification.” Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

   1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold, Hot and Recirculated Hot Water:

   1. NPS 1-1/4 and Smaller: Insulation shall be the following:
a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

2. NPS 1-1/2 and Larger: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Stormwater and Overflow, Roof Drain and Overflow Bodies and Horizontal Piping:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
      b. Provide and install protective shielding guards on hot and cold water supplies and waste piping.

D. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

3.13 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Steam-to-hot-water converter insulation shall be one of the following:
   1. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.
   4. Mineral-Fiber Preformed Pipe Insulation, Type I: 2 inches thick.

D. Domestic hot-water pump insulation shall be one of the following:
   1. Mineral-Fiber Blanket: 1 inch thick and 3-lb/cu. ft. nominal density.
   2. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.

E. Domestic hot-water storage tank insulation shall be one of the following, of thickness to provide an R-value of 12.5:
SECTION 22 08 00 – PLUMBING SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

   A. Systems and equipment Start-Up and Functional Performance Testing.
   B. Validation of proper and thorough installation of Division 23 systems and equipment.
   C. Generic Start-Up Documentation for mechanical systems and equipment.
   D. Development of final Start-Up Documentation for mechanical systems and equipment.
   E. System Start-Up and Turn-Over procedures.
   F. Systems balancing verification.
   G. Coordination and execution of Training Events.

1.2 GENERAL DESCRIPTION

   A. Commissioning (Cx) is the process of ensuring that (i) all building systems are installed and perform interactively according to the design intent; (ii) that systems are efficient and cost effective and meet the Owner’s operational needs; (iii) that the installation is accurately documented; and (iv) that the Operators are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems, and establishes testing and communication protocols to advance the building systems from installation to optimized, fully-dynamic operation.

   B. Commissioning Authority (CxA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.

   C. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.

   D. This Section outlines the Cx procedures specific to the Division 23 Contractors. Requirements common to all Sections are specified in Section 01 91 00 and Section 01 91 10. This Section and other sections of the specification details the Contractor’s responsibilities relative to the Cx process.

1.3 SCOPE

   A. The following are included in the Scope of Commissioning on this project:

   B. Plumbing Systems
       1. General Plumbing Fixtures
       2. Domestic HW heaters
1.4 RELATED WORK AND DOCUMENTS
   A. The Cx process references many related Sections, particularly Section 01 91 00 - General Commissioning. It is important for all Contractors subject to the Cx process to be familiar with Section 01 91 00.
   B. Refer to Section 01 91 00 for a complete list of Sections on Related Work.

1.5 DEFINITIONS AND ABBREVIATIONS
   A. Refer to Section 01 91 00 for a complete list of Definitions and Abbreviations.

1.6 REFERENCE STANDARDS
   A. Refer to Section 01 91 00 for a complete list of Reference Standards.

1.7 DOCUMENTATION
   A. In addition to the documentation required in Section 01 91 00, Contractor shall provide to the CxA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification.

1.8 SEQUENCING AND SCHEDULING
   A. Refer Section 01 91 00.

1.9 COORDINATION MANAGEMENT PROTOCOLS
   A. Coordination responsibilities and management protocols relative to Cx are initially defined in Section 01 91 00 and the Commissioning Plan, but shall be refined and documented in the Construction Phase Cx Kick-Off meeting. Contractor shall have input in the protocols and all Parties will commit to scheduling obligations. The CxA will record and distribute.

1.10 CONTRACTOR RESPONSIBILITIES
   A. Refer to Section 01 91 00: Detailed Contractor responsibilities common to all Divisions are specified in Section 01 91 00. The following are additional responsibilities or notable responsibilities specific to Division 22.
   B. Construction Phase
      1. Provide skilled technicians qualified to perform the work required.
      2. Provide factory-trained and authorized technicians where required by the Contract Documents.
      3. Prepare and submit required draft Start-Up Documentation and submit along with the manufacturer’s application, installation and start-up information.
      4. Provide assistance to the CxA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review FPT procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.
      5. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this Section.
6. Start-Up, test/adjust/balance, and Turn-Over systems and equipment prior to functional performance testing by the CxA. Approved Start-Up Documentation shall be in accordance with Contract Documents, reference or industry standards, and specifically in Part I of this Section.

7. Record Start-Up on approved Start-Up Documentation forms and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above and in Section 01 09 00. Each task or item shall be indicated with the Party actually performing the task or procedure.

C. Acceptance Phase
1. Assist CxA in functional performance testing. Assistance will generally include the following:
   a. Manipulate systems and equipment to facilitate Functional Performance Testing (as specified in Section 01 91 00 and Section 01 91 10);
   b. Provide any specialized instrumentation necessary for Functional Performance Testing;

D. Warranty Phase
1. Maintain record documentation of any configurations, set ups, parameters etc, that change throughout the period.
2. Provide representative for off season testing as required by CxA.
3. Respond to Warranty issues as required by Division 1 and the General Conditions.

1.11 EQUIPMENT SUPPLIER RESPONSIBILITIES
A. Refer to Section 01 91 00.

1.12 CONTRACTOR NOTIFICATION AND SCHEDULING
A. Refer to Section 01 91 00.

1.13 START-UP DOCUMENTATION
A. Refer to Section 01 91 00.

1.14 EQUIPMENT NAMEPLATE DATA
A. Refer to Section 01 91 00.

1.15 FUNCTIONAL PERFORMANCE TESTING
A. Contractor shall participate in the initial samples of Functional Performance Testing as stipulated in Section 01 91 00 and Section 01 91 10.

1.16 FPT ACCEPTANCE CRITERIA
A. Acceptance criteria for tests are indicated in Section 01 91 10 and in the specification Sections applicable to the systems being tested. Generally, unless indicated otherwise, the criteria for acceptance will be that specified with the individual system, equipment, component, or device.
1.17 **TRAINING**

A. Contractors, Subcontractor, Vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 01 91 00 and the individual Specifications.

1.18 **SYSTEMS MANUAL AND O&M DOCUMENTATION CONTENT - PREPARATION AND LOGISTICS**

A. Refer to Section 01 91 00 the individual Specifications.

**PART 2 - PRODUCTS**

2.1 **INSTRUMENTATION**

A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:

B. Temperature sensors and digital thermometers shall have a certified calibration within the past year and a resolution of + or - 0.1°F.

C. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

D. All equipment shall be calibrated according to the manufacturer’s recommended intervals. Calibration tags shall be affixed or certificates readily available.

E. Standard Testing Instrumentation: Standard instrumentation used for testing air and water flows, temperatures, humidity, noise levels, amperage, voltage, and pressure differential in air and water systems shall be provided by CxA.

F. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and turned over to the Owner upon project completion.

2.2 **WEB-BASED COMMISSIONING PORTAL**

A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal (‘Portal’) to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CxA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.

B. Refer to Section 01 91 00 the individual Specifications for additional information and requirements for using the Portal.
2.3 TEST KITS FOR METERS AND GAUGES

A. Test kits for meters and gauges shall be provided to the Owner new and in good condition. Previously used kits will be unacceptable. Kits shall be submitted prior to the Acceptance Phase. Kits included shall be as a minimum:
1. Digital indication of temperature and pressure with associated sensors to work with the P/T test ports
2. Companion readout kit (with fittings) for calibrated balancing valve with ranges as required by all devices on this project

PART 3 - EXECUTION

3.1 GENERIC START-UP DOCUMENTATION - GENERAL

A. Part III of this Section outlines ‘generic’ or minimally acceptable Start-Up Documentation (which are defined to include both ‘Start-Up Checks’ and ‘Start-Up Tests’) and individual systems training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimally acceptable guideline for required Contractor development of Start-Up Documentation. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized final Start-Up Documentation specific to the equipment and systems installed on this project.

B. Section 01 91 00 defines the systems and equipment Start-Up process in detail and provides definitions for Start-Up Documentation, including the generic Start-Up Documentation provided below.

3.2 START-UP DOCUMENTATION COMMON TO ALL SYSTEMS

A. The following Start-Up Documentation (Checklists and Tests) shall be considered common to all systems:
1. Checkout shall proceed from lower level devices to larger components to the entire system operation.
2. Verify labeling is affixed per specification and visible.
3. Verify prerequisite procedures are done.
4. Inspect for damage and ensure none is present.
5. Verify system is installed per the manufacturer’s recommendations.
6. Verify system has undergone Start-Up per the manufacturer’s recommendations.
7. Verify that access is provided for inspection, operation and repair.
8. Verify that access is provided for eventual replacement of the equipment.
9. Verify that record drawings, submittal data and O&M documentation accurately reflect the installed systems.
10. Verify all gauges and test ports are provided as required by contract documents and manufacturer’s recommendations.
11. Verify all recorded nameplate data is accurate.
12. Verify that the installation ensures safe operation and maintenance.
13. Verify specified replacement material/attic stock has been provided as required by the Contract Documents.
14. Verify all rotating and moving parts are properly lubricated.
15. Verify all monitoring and ensure all alarms are active and set per Owner’s requirements.
16. Complete all nameplate data and confirm that ratings conform to the design documents.
3.3 VALVES

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:
   1. Operate all valves, manual and automatic, through their full stroke. Ensure smooth operation through full stroke and appropriate sealing or shutoff.
   2. Verify actuators are properly installed with adequate clearance.
   3. Verify all valves are labeled per the construction documents. Confirm that concealed valves are indicated on the finished building surface.
   4. For automatic pneumatically-operated valves, verify spring range and adjust pilot positioners where applicable.
   5. For electronically operated valves, check the stroke and range.
   6. For all automated valves controlled by a program, ensure that the minimum and maximum stroke and ranges on the valves are coordinated with the limits entered in the program.

3.4 METERS AND GAUGES

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:
   1. Adjust faces of meters and gauges to proper angle for best visibility.
   2. Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.
   3. For meters and gauges requiring temporary manual connection of read-out device such as pressure taps on a flow measuring device, ensure threads are clean and that connection can be made easily.
   4. Meters and gauges requiring manual connection of readout device shall be installed with adequate access to allow connection of device with normal tools.

3.5 MECHANICAL IDENTIFICATION

A. Start-Up Checks: Perform the following checks:
   1. Verify all valve tags, piping, duct, and equipment labeling corresponds with drawings and indexes and meets requirements specified. Correct any deficiencies for all piping and duct systems.
   2. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
   3. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.6 MECHANICAL INSULATION

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Examine all piping, systems and equipment specified to be insulated.
   1. Ensure quality of insulation. Patch and repair all insulation damaged after installation.
   2. Ensure the integrity of vapor barrier around all cold surfaces.
3.7 PIPING - GENERAL

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: These procedures apply to all installed piping systems, including underground site utilities.
   1. Inspect all piping for proper installation, adequate support (with appropriate vibration isolation where applicable) and adequate isolation valves for required service.
   2. Submit welding certifications as required by the applicable specification section or referenced ASME specification.
   3. Submit certified welding inspection results per the applicable specification section or referenced ASME specification. ASME B31.1 requires 100% inspection based on pressure class.
   4. Provide notification of pipe cleaning and flushing activities.
   5. Flush and clean all piping and clean all strainers. Provide documentation of all related procedures.
   6. Ensure adequate drainage is provided at low points and venting is provided at high points.
   7. Ensure facilities to effectively drain and fill the system are in place.
   8. Ensure air is thoroughly removed from the system as applicable.
   9. Ensure all piping is adequately supported and anchored to allow expansion. Bump across-the-line pumps and inspect for excessive pipe movement.
   10. Provide notification of pressure testing.
   11. Pressure and/or leak test all applicable systems in accordance with the requirements in the applicable sections, ASME B 31.1 and 39.1 as applicable.
   12. Sterilize applicable piping systems as specified in the individual Sections and as required by regulatory authorities.
   13. Submit pressure test reports that document the pressure testing results with certification of the results.
   14. Verify the operation of applicable safety relief valves, operating controls, safety controls, etc. to ensure a safe installation.
   15. Set and adjust fill, pressure, or level controls to the required setting.

3.8 AC MOTORS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:
   1. Verify proper alignment, installation, and rotation.
   2. Verify properly sized overloads are in place

C. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up and as specified in manufacturer's instructions:
   1. Measure insulation resistance, phase balance, and resistance to ground.
   2. Measure voltage available to all phases. Measure amps and RPM after motor has been placed in operation and is under load.
   3. Record all motor nameplate data.

3.9 BEARINGS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.
B. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions. This applies to all bearings on fans, pumps, compressors, and other equipment installed under this Division.
   1. Check alignment as applicable.
   2. Lubricate all bearings per the manufacturer’s instructions. When bearing is used for temporary conditioning, lubricate on manufacturer’s recommended frequency and document it.

C. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up and as specified in manufacturer's instructions:
   1. Use infrared thermometer to measure temperature at peak conditions. Ensure temperature is below manufacturer’s recommendations.
   2. For bearings in drives with motors over 10 HP, use a vibration meter and measure the maximum peak-to-peak acceleration. Compare it to the Vibration Severity Chart. Rectify any condition causing severity indicated as “Rough” or worse.

3.10 PUMPS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Refer to ‘AC Motors’ in this Section.

C. Refer to ‘Bearings’ in this Section.

D. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

E. Start-Up Checks: Perform the following checks during start-up:
   1. Check suction lines connections for tightness to avoid drawing air into the pump.
   2. Clean and lubricate all bearings.
   3. Check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
   4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.
   5. Clean associated strainers.
   6. Check that the proper overloads have been installed in the starter and are the correct size.
   7. Verify that the integrity of the vibration isolation is maintained throughout the support and the connections.
   8. Align pump within manufacturers recommended tolerances.
   9. Ensure all associated piping has been cleaned, tested, and deaerated.
  10. Verify that all thermometers and gauges are installed, are clean and undamaged, and are functional.

F. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up:
   1. Start the pump per the manufacturer’s instructions.
   2. Check the general mechanical operation of the pump and motor.
   3. Verify that checkvalve seal is appropriate.
   4. Check noise and vibration levels and ensure they are within the manufacturer’s recommended tolerances.
   5. Check that the NPSH (Net Positive Suction Head) is within that allowable for the operating condition.
6. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.11 CONTROLLERS AND CONTROL PANELS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up:
   1. Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the record drawings.
   2. Ensure that terminations are safe, secure and labeled in accordance with the record drawings.
   3. Check power supplies for proper voltage ranges and loading.
   4. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
   5. Check for adequate signal strength and acceptable bandwidth utilization on communication networks.
   6. Check for stand-alone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at Operator Interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
   7. Ensure that all outputs and devices fail to their proper positions/states.
   8. Ensure that buffered and/or volatile information is retained through power outage.
   9. With all system and communications operating normally and all trends functioning, sample and record update/annunciation times for critical alarms fed from the panel to the Operator Interface.
  10. Check for adequate grounding of all BAS panels and devices.
  11. Run self diagnostic routines and ensure they are functional
  12. Check the memory allocation and loading to ensure adequate and excess capacity is available and that it will not affect control functionality.

3.12 PLUMBING FIXTURES

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up:
   1. Inspect each installed fixture for damage. Replace damaged fixtures and components.
   2. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.
   3. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
   4. Operate and adjust disposers, hot water dispensers, and controls. Replace damaged and malfunctioning units and controls.
   5. Adjust water pressure at drinking fountains, electric water coolers, and faucets, shower valves, and flushometers having controls, to provide proper flow and stream.
   6. Replace washers of leaking and dripping faucets and stops.
   7. Clean fixtures, fittings, and spout and drain strainers with manufacturers’ recommended cleaning methods and materials.

3.13 WATER HEATERS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.
B. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide start-up service, and demonstrate and train Owner's maintenance personnel as specified below.
   1. Check for adequate combustion air.
   2. Check for piping connections leaks.
   3. Check for clear vent.
   4. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.

C. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance. Review data in Operating and Maintenance Manuals.

3.14 ROOM/ZONE CHECKOUT

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Contractor shall complete a checklist acknowledging completion of Div. 22 responsibilities for all rooms. Checklist shall include items such as the following as applicable:

C. Rooms with Plumbing Fixtures
   1. Plumbing fixtures clean and operational.
   2. Hot water available at fixture within the specified timeframe.

3.15 SEQUENCING ILLUSTRATION

A. Reference Section 01 91 00.

END OF SECTION 220800
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
      2. Encasement for piping.

1.3 ACTION SUBMITTALS
   A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS
   A. System purging and disinfecting activities report.
   B. Field quality-control reports.

1.5 FIELD CONDITIONS
   A. Interruption of Existing Campus Water Service: The fire-suppression system shall be served by a combined fire-suppression/domestic water service entrance. Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
      1. Notify Construction Manager no fewer than two days in advance of proposed interruption of fire-suppression standpipe service.
      2. Do not proceed with interruption of fire-suppression standpipe service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS
   A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.


E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:
   1. MSS SP-123.
   4. Solder-joint or threaded ends.

G. Copper Pressure-Seal-Joint Fittings:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Elkhart Products Corporation.
      b. NIBCO Inc.
      c. Viega.
   2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
   3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:
   1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:
   1. AWWA C110/A21.10, ductile or gray iron.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe:
   1. ASTM A 53/A 53M, Type E, Grade B, Standard Weight.
   2. Include ends matching joining method.


C. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. Malleable-Iron Unions:
   1. ASME B16.39, Class 150.
   2. Hexagonal-stock body.
   4. Threaded ends.

E. Flanges: ASME B16.1, Class 125, cast iron.

2.5 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:
   1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
   2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

2.6 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105/A21.5.

B. Form: Sheet or tube.

C. Color: Black or natural.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Flanges:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
   b. Central Plastics Company.
   c. Matco-Norca.
   d. Watts; a division of Watts Water Technologies, Inc.
   e. Wilkins; a Zurn company.


3. Factory-fabricated, bolted, companion-flange assembly.

4. Pressure Rating: 125 psig minimum at 180 deg F.

5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

C. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Nonconducting materials for field assembly of companion flanges.


4. Gasket: Neoprene or phenolic.

5. Bolt Sleeves: Phenolic or polyethylene.


PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Division 22 Section "Meters and Gages for Plumbing Piping" and with
requirements for drain valves and strainers in Division 22 Section "Domestic Water Piping Specialties."

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Division 22 Section "Domestic Water Piping Specialties."

H. Install domestic water piping level without pitch and plumb.

I. Rough-in domestic water piping for water-meter and associated strainer installation according to Pennsylvania State University’s requirements. Provide full-size bypass around meter and install strainer and meter.

J. The meter and strainer will be provided by Utility Services.

K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

L. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

N. Install piping to permit valve servicing.

O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

P. Install piping free of sags and bends.

Q. Install fittings for changes in direction and branch connections.

R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

S. Install pressure gages on suction and discharge piping for each plumbing pump. Comply with requirements for pressure gages in Division 22 Section "Meters and Gages for Plumbing Piping."

T. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Division 22 Section "Domestic Water Pumps."

U. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Division 22 Section "Meters and Gages for Plumbing Piping."

V. Install sleeves for piping penetrations of walls, ceilings, and floors.

W. Install sleeve seals for piping penetrations of concrete walls and slabs.

X. Install escutcheons for piping penetrations of walls, ceilings, and floors.
3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.
B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.

G. Install supports for vertical steel piping every 15 feet.

H. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.

I. Install supports for vertical stainless-steel piping every 15 feet.

J. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code. Comply with requirements for connection sizes in Division 22 plumbing fixture Sections.

3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.6 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Division 22 Section "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:
   a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
   c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:
   a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.

f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
   b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.9 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system according to either of the following:
      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
   c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
   d. Repeat procedures if biological examination shows contamination.
   e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.10 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
C. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be the following:
   1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
D. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 6, shall be one of the following:
   1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
   2. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical joints.
E. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, shall be the following:
   1. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical joints.
F. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:
   1. Soft copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed joints.
G. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
   1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
   2. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
3. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

H. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
   1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
   2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
   3. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.

I. Aboveground domestic water piping, NPS 5 to NPS 6, shall be one of the following:
   1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
   2. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
   3. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.

J. Aboveground, combined domestic water-service and fire-service-main piping,, shall be the following:
   1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

3.11 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
   2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 22 11 16
SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Vacuum breakers.
   2. Backflow preventers.
   5. Temperature-actuated, water mixing valves.
   7. Hose bibs.
   8. Wall hydrants.
  10. Drain valves.
  12. Air vents.
  14. Flexible connectors.

B. Related Requirements:
   1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
   2. Division 22 Section "Domestic Water Piping" for water meters.
   3. Division 22 Section "Pressure Water Coolers" for water filters for water coolers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.
   1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
   b. Cash Acme; a division of Reliance Worldwide Corporation.
   c. Conbraco Industries, Inc.
   d. FEBCO; a division of Watts Water Technologies, Inc.
   e. Rain Bird Corporation.
   f. Toro Company (The); Irrigation Div.
   g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
5. Inlet and Outlet Connections: Threaded.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Arrowhead Brass Products.
   b. Cash Acme; a division of Reliance Worldwide Corporation.
   c. Conbraco Industries, Inc.
   d. Legend Valve.
   e. MIFAB, Inc.
   f. Prier Products, Inc.
   g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   h. Woodford Manufacturing Company; a division of WCM Industries, Inc.
5. Finish: Chrome or nickel plated.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:
   1. Manufacturer: The only allowable manufacturer of backflow preventers is Conbraco Industries. No substitutions shall be allowed.
   3. Operation: Continuous-pressure applications.
   4. Accessories:
      a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
      b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

B. Dual-Check-Valve Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Conbraco Industries, Inc.
      b. Legend Valve.
      c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      d. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   3. Operation: Continuous-pressure applications.

C. Hose-Connection Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Conbraco Industries, Inc.
      b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      c. Woodford Manufacturing Company; a division of WCM Industries, Inc.
   3. Operation: Up to 10-foot head of water back pressure.
   4. Inlet Size: NPS 1/2 or NPS 3/4.
   5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
   6. Capacity: At least 3-gpm flow.

D. Backflow-Preventer Test Kits:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Conbraco Industries, Inc.
   b. FEBCO; a division of Watts Water Technologies, Inc.
   c. Flomatic Corporation.
   d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

### 2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Cash Acme; a division of Reliance Worldwide Corporation.
   b. Conbraco Industries, Inc.
   c. Honeywell International Inc.
   d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   f. 

5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

### 2.6 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   b. Flo Fab Inc.
   c. ITT Corporation; Bell & Gossett Div.
   d. NIBCO Inc.
   e. TAC.
   f. TACO Incorporated.
   g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

2. Type: Y-pattern globe valve with two readout ports and memory-setting indicator.
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
B. Cast-Iron Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Flo Fab Inc.
   c. ITT Corporation; Bell & Gossett Div.
   d. NIBCO Inc.
   e. TAC.
   f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.

3. Size: Same as connected piping, but not smaller than NPS 2-1/2.

C. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

D. Memory-Stop Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Conbraco Industries, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Div.
   e. Hammond Valve.
   f. Milwaukee Valve Company.
   g. NIBCO Inc.
   h. Red-White Valve Corp.

2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.

3. Pressure Rating: 400-psig minimum CWP.

4. Size: NPS 2 or smaller.

5. Body: Copper alloy.

6. Port: Standard or full port.

7. Ball: Chrome-plated brass.

8. Seats and Seals: Replaceable.

9. End Connections: Solder joint or threaded.


2.7 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Cash Acme; a division of Reliance Worldwide Corporation.
c. Conbraco Industries, Inc.
d. Honeywell International Inc.
e. Legend Valve.
f. Leonard Valve Company.
g. Powers; a division of Watts Water Technologies, Inc.
h. Symmons Industries, Inc.
i. TACO Incorporated.
j. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
k. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlets.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Chrome plated.

B. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Cash Acme; a division of Reliance Worldwide Corporation.
   b. Conbraco Industries, Inc.
   c. Honeywell International Inc.
   d. Lawler Manufacturing Company, Inc.
   e. Leonard Valve Company.
   f. Powers; a division of Watts Water Technologies, Inc.
   g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: 105 deg F.
9. Tempered-Water Design Flow Rate: 0.5 gpm.

2.8 STRainers FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
a. Strainers NPS 2 and Smaller: 0.020 inch.
b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
c. Strainers NPS 5 and Larger: 0.10 inch.


2.9 HOSE BIBBS

A. Hose Bibbs:

4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.10 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. MIFAB, Inc.
   c. Prier Products, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products.
   g. Woodford Manufacturing Company; a division of WCM Industries, Inc.
   h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
   i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: Chrome plated.
12. Operating Keys(s): One with each wall hydrant.

B. Nonfreeze, Hot- and Cold-Water Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Prier Products, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products.
   f. Woodford Manufacturing Company; a division of WCM Industries, Inc.
   g. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

4. Operation: Loose key.
5. Casing and Operating Rods: Of length required to match wall thickness. Include wall clamps.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed.
8. Box: Deep, flush mounted with cover.
10. Vacuum Breaker:
   a. Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
   b. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.11 POST HYDRANTS

A. Nonfreeze, Nondraining-Type Sanitary Roof Post Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Woodford Manufacturing Company; a division of WCM Industries, Inc
   b. Murdock-Super Secur; a division of Acorn Engineering Company.

2. Operation: Lever-piston operating mechanism and nondraining water-storage reservoir, designed without drain.
3. Length: As required for burial of valve below frost line.
4. Inlet: NPS 1 threaded.
5. Outlet:
   a. NPS 1 outlet and coupling plug for 1-inch hose.
b. NPS 1 by NPS 3/4 adapter with nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
c. Garden-hose thread complying with ASME B1.20.7 on outlet.
d. NPS 1 by NPS 3/4 adapter with nonremovable, drainable, hose-connection backflow preventer complying with ASSE 1052.
e. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.12 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

2. Pressure Rating: 400-psig minimum CWP.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
8. Inlet: Threaded or solder joint.

2.13 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters <Insert drawing designation if any>:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. AMTROL, Inc.
   b. Josam Company.
   c. MIFAB, Inc.
   d. Precision Plumbing Products, Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   g. Tyler Pipe; Wade Div.
   h. Watts Drainage Products.
   i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
3. Type: Metal bellows.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.14 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.

B. Welded-Construction Automatic Air Vents:
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.

2.15 TRAP-SEAL PRIMER DEVICE
A. Waterless, Trap-Seal Primer Device:
1. Basis-of-Design Product: Subject to compliance with requirements, provide ProSet Trap Guard® or comparable product by the following, but is not limited to:
   a. Sure Seal Manufacturing.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.16 SPECIALTY VALVES
A. Comply with requirements for general-duty metal valves in Division 22 Section "General-Duty Valves for Plumbing Piping."

2.17 FLEXIBLE CONNECTORS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Flex Pression, Ltd.
4. Flex-Weld Incorporated.
5. Hyspan Precision Products, Inc.
7. Metraflex, Inc.
8. Proco Products, Inc.
9. TOZEN Corporation.
10. Unaflex.
11. Universal Metal Hose; a Hyspan company.
B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.18 WATER METERS

A. The water meter and strainer to be installed by the contractor will be provided by University Park Utility Water Services:

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

C. Install water-control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.

D. Install balancing valves in locations where they can easily be adjusted.

E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified.

F. Install Y-pattern strainers for water on supply side of each control valve water pressure-reducing valve solenoid valve and pump.

G. Set nonfreeze, nondraining-type post hydrants on roof and secured per manufacturer's recommendations.
H. Install water-hammer arresters in water piping according to PDI-WH 201.
I. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
J. Floor drains shall be protected using waterless trap primers (ProSet Trap Guard ®).

3.2 CONNECTIONS
A. Comply with requirements for piping specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Comply with requirements for ground equipment in Division 26 Section "Grounding and Bonding for Electrical Systems."
C. Fire-retardant-treated-wood blocking is specified in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 LABELING AND IDENTIFYING
A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Pressure vacuum breakers.
   2. Reduced-pressure-principle backflow preventers.
   5. Primary, thermostatic, water mixing valves.
B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL
A. Perform the following tests and inspections:
   1. Test each pressure vacuum breaker and reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

3.5 ADJUSTING
A. Set field-adjustable pressure set points of water pressure-reducing valves.
B. Set field-adjustable flow set points of balancing valves.
C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 22 11 19
SECTION 22 11 23 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Horizontally mounted, in-line, close-coupled centrifugal pumps.
   B. Related Sections include the following:
      1. Division 22 Section "Domestic-Water Packaged Booster Pumps" for booster systems.
      2. Division 33 Section "Water Supply Wells" for well pumps.

1.3 DEFINITIONS
   A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or
      for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated. Include materials of construction, rated
      capacities, certified performance curves with operating points plotted on curves, operating
      characteristics, electrical characteristics, and furnished specialties and accessories.
   B. LEED Submittals:
      1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with
         applicable requirements in ASHRAE/IESNA 90.1, without amendments, Section 7 -
         "Service Water Heating."

1.5 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For domestic water pumps to include in operation and
      maintenance manuals.

1.6 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70,
      by a qualified testing agency, and marked for intended location and application.
B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.
B. Protect bearings and couplings against damage.
C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 HORIZONTALLY MOUNTED, IN-LINE, CLOSE-COUPLING CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Armstrong Pumps Inc.
   2. Bell & Gossett Domestic Pump; ITT Corporation.
   3. TACO Incorporated.

B. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.

C. Performance: Refer to schedule on Plumbing Drawings.

D. Pump Construction:

   1. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
   2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
   3. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
   4. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
   5. Bearings: Oil-lubricated; bronze-journal or ball type.
   6. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

E. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.3 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation DHWP-1 pump.
   1. Type: Water-immersion temperature sensor, for installation in piping.
   2. Range: 65 to 200 deg F.
   3. Enclosure: NEMA 250, Type 4X.
   4. Operation of Pump: On or off.
   5. Transformer: Provide if required.
   7. Settings: Start pump at 105 deg F and stop pump at 120 deg F.

B. Timers: Electric, for control of hot-water circulation DHWP-1 pump.
   1. Type: Programmable, seven-day clock with manual override on-off switch.
   2. Enclosure: NEMA 250, Type 1, suitable for wall mounting.
   3. Operation of Pump: On or off.
   4. Transformer: Provide if required.
   5. Power Requirement: 24-V ac.
   6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install horizontally mounted, in-line, close-coupled centrifugal pumps with shaft(s) horizontal.

C. Install continuous-thread hanger rods and spring hangers with vertical-limit stop of size required to support pump weight.
   1. Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required.
   2. Comply with requirements for hangers and supports specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

D. Install thermostats in hot-water return piping.

E. Install timers on wall in mechanical room adjacent to the water heater.
F. Coordinate control points, and sequences, with the building automation contractor.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
   1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
      a. Horizontally mounted, in-line, close-coupled centrifugal pumps.
      b. Comply with requirements for flexible connectors specified in Division 22 Section "Domestic Water Piping."
   2. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping" and comply with requirements for strainers specified in Division 22 Section "Domestic Water Piping Specialties."
   3. Install pressure gage and snubber at suction of each pump and pressure gage and snubber at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Division 22 Section "Meters and Gages for Plumbing Piping."

D. Comply with Division 26 Sections for electrical connections, and wiring methods.

E. Connect thermostats, and timers to pumps that they control.

F. Coordinate with the automatic temperatures controls contractor for monitoring and control of DHWP-1 from front end.

3.4 IDENTIFICATION

A. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. Clean strainers on suction piping.
   4. Set thermostats and timers for automatic starting and stopping operation of pumps.
   5. Perform the following startup checks for each pump before starting:
a. Verify bearing lubrication.
b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
c. Verify that pump is rotating in the correct direction.

6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.6 ADJUSTING

A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 22 11 23
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Pipe, tube, and fittings.
      2. Specialty pipe fittings.

1.3 PERFORMANCE REQUIREMENTS
   A. Components and installation shall be capable of withstanding the following minimum working
      pressure unless otherwise indicated:

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: For solvent drainage system. Include plans, elevations, sections, and details.

1.5 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.

1.6 QUALITY ASSURANCE
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS
   A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting
      materials, and joining methods for specific services, service locations, and pipe sizes.
2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy class.

B. Gaskets: ASTM C 564, neoprene rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:
   2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:
   2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.
J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

N. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

O. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."
2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."

P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Q. Install sleeves for piping penetrations of walls, ceilings, and floors.

R. Install sleeve seals for piping penetrations of concrete walls and slabs.

S. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.2 JOINT CONSTRUCTION


B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. Install individual, straight, horizontal piping runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls.
   Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.4 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Comply with requirements for cleanouts and drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.5 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.6 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.
3.7  PIPING SCHEDULE

A. Aboveground, soil and waste piping shall be the following:

1. Service class, hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

B. Aboveground, vent piping shall be the following:

1. Service class, hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

C. Underground, soil, waste, and vent piping shall be the following:

1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.

END OF SECTION 22 13 16
SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Floor drains.
4. Flashing materials.

B. Related Requirements:

1. Division 22 Section "Storm Drainage Piping Specialties" for storm drainage piping inside the building, drainage piping specialties, and drains.
2. Division 33 Section "Storm Utility Drainage Piping" for storm draining piping and piping specialties outside the building.

1.3 ACTION SUBMITTALS

A. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


1.6 COORDINATION
A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor Cleanouts:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   b. Oatey.
   c. Sioux Chief Manufacturing Company, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Zurn Plumbing Products Group; Light Commercial Operation.
   h. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
7. Outlet Connection: Spigot.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Medium Duty.
13. Riser: ASTM A74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.
15. Size: Same as connected branch.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains. Refer to schedule on Plumbing Drawings for sizes and basis of design manufacturers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Light Commercial Operation.
   g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.3.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom or Side.
10. Sediment Bucket: Not required.
2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Air-Gap Fittings:
   1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
   2. Body: Bronze or cast iron.
   3. Inlet: Opening in top of body.
   4. Outlet: Larger than inlet.
   5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

B. Sleeve Flashing Device:
   1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
   2. Size: As required for close fit to riser or stack piping.

C. Stack Flashing Fittings:
   1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
   2. Size: Same as connected stack vent or vent stack.

D. Frost-Proof Vent Terminals:
   1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
   2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

E. Sewer Gas and Sewage Backup Protection for Floor Drains: ProSet Systems, Inc Trap Guard®:
   1. Material: Smooth, soft, flexible, elastomeric PVC material molded into shape of duck’s bill, open on top with curl closure at bottom.
   2. Allows wastewater to open and adequately discharge floor drain through its interior.
   3. Closes and returns to original molded shape after wastewater discharge is complete.

2.4 FLASHING MATERIALS

A. Neoprene rubber boots with stainless steel clamps.

B. Fasteners: Metal compatible with material and substrate being fastened.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
      a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
      b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
      c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

F. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

G. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

H. Install wood-blocking reinforcement for wall-mounting-type specialties.

I. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS
A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION
A. Install flashing for piping passing through roofs with neoprene rubber boots and stainless steel clamps.

3.4 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19
SECTION 22 14 13 - FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Pipe, tube, and fittings.
B. Related Sections:
   1. Division 22 Section "Sump Pumps" for storm drainage pumps.
   2. Division 33 Section "Storm Utility Drainage Piping" for storm drainage piping outside the building.

1.3 PERFORMANCE REQUIREMENTS
A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Storm Drainage Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

1.6 QUALITY ASSURANCE
A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS
A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy class.
B. Gaskets: ASTM C 564, neoprene rubber.
C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.
B. CISPI, Hubless-Piping Couplings:
   2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
C. Heavy-Duty, Hubless-Piping Couplings:
   2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.
B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
E. Install piping at indicated slopes.
F. Install piping free of sags and bends.
G. Install fittings for changes in direction and branch connections.
H. Install piping to allow application of insulation.

I. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

J. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

K. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
   1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

L. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

M. Plumbing Specialties:
   1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Storm Drainage Piping Specialties."
   2. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Storm Drainage Piping Specialties."

N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

O. Install sleeves for piping penetrations of walls, ceilings, and floors.

P. Install sleeve seals for piping penetrations of concrete walls and slabs.

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.2 JOINT CONSTRUCTION


B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

3.3 HANGER AND SUPPORT INSTALLATION
A. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls.
   Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.4 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

   1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
   2. Comply with requirements for cleanouts and drains specified in Division 22 Section "Storm Drainage Piping Specialties."

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.5 IDENTIFICATION
A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.6 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.7 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping shall be the following:

1. Service class, hubless, cast-iron soil pipe and fittings; CISPI, hubless-piping couplings; and coupled joints.

C. Underground storm drainage piping shall be the following:

1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.

END OF SECTION 22 14 13
SECTION 22 14 23 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Roof drains.
   2. Miscellaneous storm drainage piping specialties.
   3. Cleanouts.
   4. Through-penetration firestop assemblies.
   5. Flashing materials.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE
A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS
A. Cast-Iron, Small-Sump, General-Purpose Roof Drains RD-1:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. Marathon Roofing Products.
      c. MIFAB, Inc.
      e. Tyler Pipe.
      f. Watts Water Technologies, Inc.
      g. Zurn Plumbing Products Group; Light Commercial Products Operation.
      h. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.4, for general-purpose roof drains.
5. Combination Flashing Ring and Gravel Stop: Required.
6. Outlet: Bottom.
7. Extension Collars: Required.
8. Underdeck Clamp: Required.
10. Sump Receiver Plate: Not required.
12. Wire Mesh: Not required.

B. Cast-Iron, Small-Sump, Overflow Standpipe Roof Drains OD-1:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Marathon Roofing Products.
   c. MIFAB, Inc.
   e. Tyler Pipe.
   f. Watts Water Technologies, Inc.
   g. Zurn Plumbing Products Group; Light Commercial Products Operation.
   h. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.4, for general-purpose roof drains.
5. Combination Flashing Ring and Gravel Stop: Required.
6. Outlet: Bottom.
7. Extension Collars: Required.
8. Underdeck Clamp: Required.
10. Sump Receiver Plate with adjustable Bronze Standpipe: Required.
12. Wire Mesh: Not required.

C. Cast-Iron, Medium-Sump, Planting Area Roof Drains RD-2:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Marathon Roofing Products.
   c. MIFAB, Inc.
   d. Portals Plus; Commercial Products Group of Hart & Cooley, Inc.
   f. Tyler Pipe.
   g. Watts Water Technologies, Inc.
   h. Zurn Plumbing Products Group; Light Commercial Products Operation.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.4, for general-purpose roof drains.
5. Combination Flashing Ring and Gravel Stop: Not required.
7. Outlet: Bottom.
8. Extension Collars: Required.
10. Expansion Joint: Not required.
11. Sump Receiver Plate: Not required.
15. Vandal-Proof Dome: Required.
16. Water Dam: Not required.

D. Cast-Iron, Floor Drains AD-2:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Light Commercial Operation.
   g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.3.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
10. Sediment Bucket: Not required.
12. Grate Shape: Square.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Overflow Drain Nozzles DSN:

1. Description: Cast Bronze body with threaded inlet and bronze wall flange with mounting holes. Drip edge lip extending 4 inches from the face of the building
2. Size: Same as connected conductor.

2.3 CLEANOUTS

A. Exposed Metal Cleanouts:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor Cleanouts:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Oatey.
   c. Sioux Chief Manufacturing Company, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Zurn Plumbing Products Group; Light Commercial Operation.
   h. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
7. Outlet Connection: Spigot.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Medium Duty.
13. Riser: ASTM A 74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.
15. Size: Same as connected branch.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.4 FLASHING MATERIALS


B. Fasteners: Metal compatible with material and substrate being fastened.

C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

D. Solder: ASTM B 32, lead-free alloy.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07 Sections.
   1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Install expansion joints, if indicated, in roof drain outlets.
   3. Position roof drains for easy access and maintenance.

B. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

C. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
   1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
   3. Locate cleanouts at minimum intervals of 50 feet.
   4. Locate cleanouts at base of each vertical soil and waste stack.
D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

F. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

G. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.

H. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.

2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.

3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

B. Set flashing on floors and roofs in solid coating of bituminous cement.

C. Secure flashing into sleeve and specialty clamping ring or device.

D. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 14 23
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Packaged drainage-pump units.
2. Submersible effluent pumps.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS
2.1 PACKAGED DRAINAGE-PUMP UNITS

A. Packaged Submersible Drainage-Pump Units:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Bell & Gossett Domestic Pump; ITT Corporation.
   b. Goulds Pumps; ITT Corporation.
   c. Grundfos Pumps Corp.
   d. Zoeller Company.

2. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, sump-pump unit.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.


5. Impeller: Brass.

6. Pump Seal: Mechanical.


8. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches, with grounding plug and cable-sealing assembly for connection at pump.

9. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings.


11. Basin: None

2.2 SUBMERSIBLE EFFLUENT PUMPS

A. Submersible, Quick-Disconnect, Effluent Pumps:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Stancor, Inc.
   c. Zoeller Company.

2. Description: Factory-assembled and -tested effluent-pump unit with guide-rail supports.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.

4. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.

5. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron, closed or semiopen design for clear wastewater, and keyed and secured to shaft.


7. Seals: Mechanical.

8. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.

9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
a. Motor Housing Fluid: Oil.

10. Controls:
   a. Enclosure: NEMA 3R.
   b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
   c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps
      if one cannot handle load.
   d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater
      than 60 inches.
   e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell;
      120-V ac, with transformer and contacts for remote alarm bell.

11. Control-Interface Features:
   b. Building Automation System Interface: Auxiliary contacts in pump controls for
      interface to building automation system and capable of providing the following:
      1) On-off status of pump.
      2) Alarm status.

12. Guide-Rail Supports:
   b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or
      other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
   c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting
      guide rails and stationary elbow.
   d. Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for
      aligning pump during connection of flanges.
   e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning
      device.
   f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-
      elbow flange and support attached to baseplate.
   g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

2.3 SUMP-PUMP BASINS AND BASIN COVERS

A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall
   openings for pipe connections.
   2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
   3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to
      sump, in location and of size required to anchor basin in concrete slab.

B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for
   access to pumps, pump shafts, control rods, discharge piping, vent connections, and power
   cables.
   1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins.
   2. Cover Material: Galvanized steel or other corrosion-resistant metal compatible with
      attached guide-rail supports.
3. Cover Diameter: Not less than outside diameter of basin top flange.
4. Manhole Required in Cover: Yes.
5. Vent Required in Cover: Yes.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Division 31 Section "Earth Moving."

3.2 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.3 INSTALLATION

A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.
B. Coordinate control points, and sequences, with the building automation contractor.

3.4 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.5 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.
C. Coordinate with the automatic temperature controls contractor to provide a status of pump operation, high level alarm, and general fault.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Pumps and controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

END OF SECTION 22 14 29
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes piping and related specialties for general-service compressed-air systems operating at 200 psig or less.
B. Related Sections include the following:
   1. Division22 Section "General-Service Packaged Air Compressors and Receivers" for general-service air compressors and accessories.

1.3 DEFINITIONS
A. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig or less.

1.4 ACTION SUBMITTALS
A. Product Data: For the following:
   1. Flexible pipe connectors.
   2. Pressure regulators. Include rated capacities and operating characteristics.

1.5 INFORMATIONAL SUBMITTALS
A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For general-service compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE
A. ASME Compliance:
1.8 PROJECT CONDITIONS

A. Interruption of Existing Compressed-Air Service: Do not interrupt compressed-air service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary compressed-air service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of compressed-air service.
2. Do not proceed with interruption of compressed-air service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Schedule 40, Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded according to ASME B1.20.1.


2.2 VALVES

A. Metal Ball, Check, Gate, and Globe Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping."

2.3 FLEXIBLE PIPE CONNECTORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Flex-Hose Co., Inc.
2. Hyspan Precision Products, Inc.
3. Metraflex, Inc.

B. Stainless-Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

2. End Connections, NPS 2 and Smaller: Threaded steel pipe nipple.
3. End Connections, NPS 2-1/2 and Larger: Flanged steel nipple.

2.4 SPECIALTIES

A. Air-Line Pressure Regulators: Diaphragm or pilot operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig minimum inlet pressure, unless otherwise indicated.
PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Low-Pressure Compressed-Air Distribution Piping: Use the following piping materials for each size range:

1. Schedule 40, galvanized-steel pipe; threaded, malleable-iron fittings; and threaded joints.

3.2 VALVE APPLICATIONS

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for metal general-duty valves.

1. Metal General-Duty Valves: Use valve types specified in "Valve Applications" Article in Division 22 Section "General-Duty Valves for Plumbing Piping" according to the following:

   a. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
   b. Equipment Isolation NPS 2 and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.

E. Install piping adjacent to equipment and machines to allow service and maintenance.

F. Install air and drain piping with 1 percent slope downward in direction of flow.

G. Equipment and Specialty Flanged Connections:

1. Use steel companion flange with gasket for connection to steel pipe.
2. Use cast-copper-alloy companion flange with gasket and brazed joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.
H. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

I. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

J. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division22 Section "Meters and Gages for Plumbing Piping."

K. Install piping to permit valve servicing.

L. Install piping free of sags and bends.

M. Install fittings for changes in direction and branch connections.

N. Install sleeves for piping penetrations of walls, ceilings, and floors

O. Install sleeve seals for piping penetrations of concrete walls and slabs.

P. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.5 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division22 Section "General-Duty Valves for Plumbing"

B. Install shutoff valves and unions at compressed-air piping to air compressors.

C. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.

D. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

3.6 FLEXIBLE PIPE CONNECTOR INSTALLATION
A. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter of each air compressor.

B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.

C. Install stainless-steel-hose flexible pipe connectors in steel compressed-air piping.

3.7 SPECIALTY INSTALLATION

A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

B. Install air-main pressure regulators in compressed-air piping at or near air compressors.

C. Install air-line pressure regulators in branch piping to equipment.

D. Install automatic drain valves on aftercoolers, receivers, and dryers. Discharge condensate onto nearest floor drain.

E. Install coalescing filters in compressed-air piping at or near air compressors and upstream from mechanical filters. Mount on wall at locations indicated.

F. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters. Mount on wall at locations indicated.

G. Install air-line lubricators in branch piping to machine tools. Mount on wall at locations indicated.

H. Install quick couplings at piping terminals for hose connections.

I. Install hose assemblies at hose connections.

3.8 CONNECTIONS

A. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.

3.9 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

B. Vertical Piping: MSS Type 8 or 42, clamps.

C. Individual, Straight, Horizontal Piping Runs:
   1. 100 Feet or Less: MSS Type 1, adjustable, steel clevis hangers.
   2. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
E. Base of Vertical Piping: MSS Type 52, spring hangers.

F. Support horizontal piping within 12 inches of each fitting and coupling.

G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

H. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4 to NPS 1/2: 96 inches with 3/8-inch rod.
2. NPS 3/4 to NPS 1-1/4: 84 inches with 3/8-inch rod.
3. NPS 1-1/2: 12 feet with 3/8-inch rod.
4. NPS 2: 13 feet with 3/8-inch rod.

I. Install supports for vertical, Schedule 40, steel piping every 15 feet.

3.10 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.11 FIELD QUALITY CONTROL

A. Perform field tests and inspections.

B. Tests and Inspections:

1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
2. Repair leaks and retest until no leaks exist.
3. Inspect pressure regulators for proper operation.

C. Prepare test reports.

END OF SECTION 22 15 13
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following general-service compressed-air equipment and related accessories:

1. Air compressors and receivers.
2. Air-inlet filters.
3. Compressed-air dryers.
4. Compressed-air filter assemblies.

B. Related Sections include the following:

1. Division 22 Section "General-Service Compressed-Air Piping" for compressed-air piping, valves, and related specialties.

1.3 DEFINITIONS

A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm.

B. Standard Air: Free air at 68 deg F and 1 atmosphere (29.92 in. Hg) before compression or expansion and measured in scfm.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following compressed-air equipment:

1. Air compressors, including receivers and intake filters.
2. Compressed-air dryers.
3. Compressed-air filter assemblies.

B. Product Certificates: Certificates of shop inspection and data report for receiver tanks as required by ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. Startup service reports.
D. Operation and Maintenance Data: For the following compressed-air equipment and
accessories to include in emergency, operation, and maintenance manuals:

1. Air compressors.
2. Compressed-air dryers.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70,
Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for
intended use.

B. ASME Compliance: Fabricate and label receiver tanks to comply with ASME Boiler and
Pressure Vessel Code: Section VIII, Division 1.

C. Comply with NFPA 70, "National Electrical Code."

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged
with protective covering for storage and identified with labels describing contents.

1. Air-Compressor Inlet-Filter Element Units: 4 required.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for
product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers
offering products that may be incorporated into the Work include, but are not limited to,
the manufacturers specified.

2.2 PACKAGED AIR COMPRESSORS AND RECEIVERS

A. Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled;
continuous-duty air compressors and receivers that deliver air of quality equal to intake air.

B. Control Panels: Automatic control station with load control and protection functions. Comply
with NEMA ICS 2 and UL 508.

1. Mounting and Wiring: Factory installed and connected as an integral part of equipment
package.
2. Enclosure: NEMA ICS 6, Type 12 control panel, unless otherwise indicated.
3. Motor Controllers: Full-voltage, combination-magnetic type with undervoltage release
feature and motor-circuit-protector-type disconnecting means and short-circuit protective
device.
a. Control Voltage: 120-V ac or less, using integral control power transformer.
b. Motor Overload Protection: Overload relay in each phase.
c. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.

1) Automatic control switches to alternate lead-lag compressors for duplex air compressors.

4. Instrumentation: Include receiver pressure gage, discharge-air pressure gage, air-filter maintenance indicator, hour meter, compressor discharge-air temperature gages, and control transformer.

C. Motors: Comply with requirements in Division 23 Section "Motors."

D. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1; rated for working pressure at least as high as highest discharge pressure of connected compressors; and bearing appropriate code symbols. Include safety valve, pressure gage, automatic drain, and pressure-reducing valve.

E. Fabricate base and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

2.3 RECIPROCATING AIR COMPRESSORS

A. Lubricated, Reciprocating Air Compressors: Duplex unit.

1. Manufacturers:
   a. Quincy Compressor.

2. Compressor(s): Single-stage, lubricated, reciprocating-piston type with lubricated compression chamber and crankcase.
   b. Number of Compressors: Two.
   c. Motor Size (Each Compressor): 3 hp, 500 rpm, 3 phase, 60 Hz.
   d. Actual-Air Capacity of Each Air Compressor: 10 acfm delivered, continuous duty.
   e. Discharge Air Pressure: 100 psig.
   f. Combined high discharge-air temperature and low lubrication-oil pressure switch, submerged gear-type oil pump, and oil filter.
   g. Belt guards totally enclosing pulleys and belts.

   a. Orientation: Horizontal arrangement.
   b. Capacity: 120 gal..
   c. Pressure Rating: 125 psig minimum.

2.4 AIR-INLET FILTERS

A. Description: Combination inlet filter-silencer, suitable for remote installation, for each air compressor.

1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
2. Capacity: Match capacity of air compressor, with collection efficiency of 99 percent retention of particles larger than 10 microns.

2.5 COMPRESSED-AIR DRYERS

A. Refrigerant-Type Dryers: Noncycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver 35 deg F, 100-psig air at dew point. Include automatic ejection of condensate from airstream, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.

1. Manufacturers:
   a. Hankison International.
2. Capacity: Match maximum capacity of connected air compressor.
3. Inlet Filter: 5 microns.
4. Outlet Filter: 1 micron.

2.6 ACCESSORIES

A. General: Include accessories with working-pressure rating not less than system pressure at location where used, and compatible with equipment and piping system used.

2.7 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet safety valve for compressed-air service.

1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Automatic Drain Valves: mechanical-operation type with corrosion-resistant metal body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate.

C. Pressure Regulators: Aluminum alloy or plastic body, diaphragm operated, direct acting, spring loaded, manual pressure-setting adjustment, and rated for 125-psig inlet pressure, unless otherwise indicated.
PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Install air compressors on concrete bases. Install units level, plumb, and anchored to substrate in locations indicated. Maintain manufacturers' recommended clearances. Orient equipment so controls and devices are accessible for servicing.

1. Anchor packaged equipment to concrete base.
   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
   b. Install epoxy-coated anchor bolts for supported equipment; extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Vibration Isolation: Install restrained spring isolators with a minimum deflection of 1". Vibration isolation devices and installation requirements are specified in Division 23 Section "Mechanical Vibration and Seismic Controls."

C. Vibration Isolation: Mount equipment with motors larger than 5 hp on vibration isolation equipment base as specified in Division 23 Section "Mechanical Vibration and Seismic Controls."

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Install the following devices on compressed-air equipment:
   1. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
   2. Pressure Regulators: Install downstream from air compressors, dryers, purification units, and filter assemblies.

3.2 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance, with a minimum of three 90 degree elbows in different planes.
C. Connect piping to air compressors and receivers, except safety relief valve connections, with flexible pipe connectors of materials suitable for service. Flexible pipe connectors and their installation are specified in Division 22 Section "General-Service Compressed-Air Piping."

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to test, inspect, and adjust components and equipment installation and to perform startup service.

B. Perform the following final checks:
   1. Verify that specified tests of piping systems are complete.
   2. Check for piping connection leaks.
   3. Check for lubricating oil in lubricated-type equipment.
   4. Check belt drives for proper tension.
   5. Verify that air-compressor inlet filters and piping are clear.
   6. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
   7. Check safety valves for correct settings. Ensure that settings are greater than air-compressor discharge pressure but not greater than rating of system components.
   8. Test operation of equipment safety controls and devices.

C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Complete installation and startup checks according to manufacturer's written instructions.

F. Prepare written report documenting testing procedures and results.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain general-service compressed-air equipment. Refer to Division 1 Sections.

END OF SECTION 22 15 19
SECTION 22 35 00 - DOMESTIC-WATER HEAT EXCHANGERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:

1.3 ACTION SUBMITTALS
A. Product Data: For each type and size of domestic-water heat exchanger indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
B. Shop Drawings:
   1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
A. Product Certificates: For each type of shell-and-tube, domestic-water heat exchanger, from manufacturer.
B. Domestic-Water, Heat-Exchanger Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For domestic-water heat exchangers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label heat-exchanger storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate with the automatic temperature controls contractor to provide domestic hot water supply temperature out, as well as interfacing the control of the steam inlet valve.

PART 2 - PRODUCTS

2.1 SHELL-AND-TUBE, DOMESTIC-WATER HEAT EXCHANGERS

A. Shell-and-Tube, Heating-Fluid-in-U-Tube-Coil, Domestic-Water Heat Exchangers:

1. The contractor shall provide a Patterson-Kelley PK-06D water heater. No substitutions will be allowed.

2. Description: Tankless, packaged assembly of heat-exchanger coil, controls, and specialties for heating domestic water in shell with steam in coil.

3. Construction: ASME-code, negligible-capacity, copper-lined, carbon-steel or copper-alloy shell with 150-psig minimum working-pressure rating.

   b. Shell Tappings: Factory fabricated of materials compatible with domestic-water, heat-exchanger shell. Attach tappings to shell before testing and labeling.

      1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
      2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

   c. Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire shell and nozzle except connections and controls.

4. Heat-Exchanger Coil: Copper, double-wall U tubes for heating fluid. Include tube pressure rating equal to or greater than heating-fluid supply pressure.

5. Temperature Control: Adjustable thermostat that operates steam-control valve and is capable of maintaining outlet-water temperature within 5 deg F of setting.

6. Safety Control: Automatic, high-temperature-limit cutoff device or system.

7. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into shell.
8. Miscellaneous Components for Steam Unit: Strainers, steam-control valve, steam trap, valves, pressure gage, thermometer, and piping. Include components fitted for pneumatic control.


PART 3 - EXECUTION

3.1 DOMESTIC-WATER, HEAT-EXCHANGER INSTALLATION

A. Domestic-Water, Heat-Exchanger Mounting: Install domestic-water heat exchangers on concrete base. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor heat exchangers to substrate.

B. Install domestic-water heat exchangers level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to heat exchangers and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
2. Install shutoff valves on steam and condensate piping to heat exchangers. Comply with requirements for shutoff valves specified in Division 23 Section "General-Duty Valves for HVAC Piping."

C. Install temperature and pressure relief valves in top portion of shells of domestic-water heat exchangers. Use relief valves with sensing elements that extend into shells. Extend relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install heat-exchanger drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heat exchangers that do not have tank drains. Comply with requirements for hose-end drain valves specified in Division 22 Section "Domestic Water Piping Specialties."

E. Install thermometer on each domestic-water, heat-exchanger, inlet and outlet piping, and install thermometer on each domestic-water, heat-exchanger, heating-fluid inlet and outlet piping. Comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."

F. Install pressure gages on domestic-water, heat-exchanger, heating-fluid piping. Comply with requirements for pressure gages specified in Division 22 Section "Meters and Gages for Plumbing Piping."
G. Fill domestic-water heat exchangers with water.

H. Coordinate control points, and sequences, with the building automation contractor.

3.2 CONNECTIONS
A. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping."

B. Comply with requirements for heating hot-water piping specified in Division 23 Section "Hydronic Piping."

C. Comply with requirements for steam and condensate piping specified in Division 23 Section "Steam and Condensate Heating Piping."

D. Drawings indicate general arrangement of piping, fittings, and specialties.

E. Where installing piping adjacent to domestic-water heat exchangers, allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of domestic-water heat exchangers.

3.3 IDENTIFICATION
A. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL
A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heat exchangers will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

END OF SECTION 22 35 00
SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:

1. Faucets for lavatories showers and sinks.
2. Flushometers.
3. Toilet seats.
4. Protective shielding guards.
5. Fixture supports.
7. Urinals.
8. Lavatories.
10. Service sinks.

B. Related Sections include the following:

1. Division 22: "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
2. Division 22 Section "Drinking Fountains."

1.3 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   2. Vitreous-China Fixtures: ASME A112.19.2M.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
   1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
   2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
   5. Hose-Connection Vacuum Breakers: ASSE 1011.

I. Comply with the following applicable standards and other requirements specified for shower faucets:
   1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
   2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

2. Brass and Copper Supplies: ASME A112.18.1.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:

2. Floor Drains: ASME A112.6.3.
4. Off-Floor Fixture Supports: ASME A112.6.1M.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

A. Lavatory Faucets:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. American Standard Companies, Inc.
   b. Delta Faucet Company.
   c. Kohler Co.
   d. Speakman Company.
   e. T & S Brass and Bronze Works, Inc.

2.2 SHOWER FAUCETS

A. Shower Faucets:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. American Standard Companies, Inc.
   b. Central Brass Manufacturing Company.
   c. Chicago Faucets.Delta Faucet Company.
   d. Kohler Co.
2.3 SINK FAUCETS

A. Sink Faucets:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. American Standard Companies, Inc.
   b. Chicago Faucets.
   c. Delta Faucet Company.
   d. Elkay Manufacturing Co.
   e. Kohler Co.
   f. Speakman Company.
   g. T & S Brass and Bronze Works, Inc.

2.4 FLUSHOMETERS

A. Flushometers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   b. Sloan Valve Company.
   c. TOTO USA, Inc.
   d. Zurn Plumbing Products Group; Commercial Brass Operation.

2.5 TOILET SEATS

A. Toilet Seats:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. American Standard Companies, Inc.
   b. Bemis Manufacturing Company.
   c. Church Seats.
   d. Kohler Co.
   e. Olsonite Corp.

2.6 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Piping Enclosures:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. TRUEBRO, Inc.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

2.7 FIXTURE SUPPORTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Josam Company.
2. MIFAB Manufacturing Inc.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.

B. Water-Closet Supports:

1. Description: Combination carrier designed for wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

C. Urinal Supports:

1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.


D. Lavatory Supports:

1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.


E. Sink Supports:

1. Description: Type II, sink carrier with hanger plate, bearing studs, and tie rod for sink-type fixture. Include steel uprights with feet.

2.8 WATER CLOSETS

A. Water Closets:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. American Standard Companies, Inc.
   b. Crane Plumbing, L.L.C./Fiat Products.
   c. Kohler Co.
   d. TOTO USA, Inc.
2.9 URINALS

A. Urinals:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. American Standard Companies, Inc.
   b. Crane Plumbing, L.L.C./Fiat Products.
   c. Kohler Co.
   d. TOTO USA, Inc.

2.10 LAVATORIES

A. Lavatories:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. American Standard Companies, Inc.
   b. Crane Plumbing, L.L.C./Fiat Products.
   c. Kohler Co.
   d. TOTO USA, Inc.

2.11 KITCHEN SINKS

A. Kitchen Sinks:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. Dayton Products, Inc.
   b. Elkay Manufacturing Co.
   c. Just Manufacturing Company.
   d. Kohler Co.

2.12 SERVICE BASINS

A. Service Basins:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   b. Precast Terrazzo Enterprises, Inc.
   c. Zurn Plumbing Products Group; Light Commercial Operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install wall-mounting fixtures with tubular waste piping attached to supports.

E. Install counter-mounting fixtures in and attached to casework.

F. Install fixtures level and plumb according to roughing-in drawings.

G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
   1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

I. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

J. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

K. Install toilet seats on water closets.

L. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

M. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

N. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

O. Install shower flow-control fittings with specified maximum flow rates in shower arms.
P. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

Q. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings.

R. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

D. Install fresh batteries in sensor-operated mechanisms.
3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 40 00
SECTION 22 47 16 - PRESSURE WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes pressure water coolers and related components.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of pressure water cooler.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS
A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS
A. Pressure Water Coolers EWC-1: Flush to wall.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Elkay Manufacturing Co.
      b. Halsey Taylor.
      c. Haws Corporation.
   2. Standards:
      a. Comply with NSF 61.
b. Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.

3. Cabinet: All stainless steel.

4. Style: Bi-Level, each level with individual bubblers to accommodate standing users as well as providing barrier free access.

5. Bubbler: One, with adjustable stream regulator, located on deck.

6. Control: Push button.

7. Drain: Grid with NPS 1-1/4 tailpiece.


10. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards, with capacity sized for unit peak flow rate.

11. Cooling System: Electric, with precooler, hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

   a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 EXAMINATION

   A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

   B. Examine walls and floors for suitable conditions where fixtures will be installed.

   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

   A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

   B. Set freestanding pressure water coolers on floor.

   C. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

   D. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers to mounting frames.

   E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ballvalve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Division 22 Section "Escutcheons for Plumbing Piping."

H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Division 22 Section "Domestic Water Piping."

C. Install ball, gate, or globe shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler. Comply with valve requirements specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Division 22 Section "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust pressure water-cooler temperature settings.

3.5 CLEANING

A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 47 16
SECTION 22 52 00 - WATER FEATURE MECHANICAL SYSTEM

PART 1 – GENERAL

1.1 SCOPE OF WORK

Furnish all labor, materials, supplies, equipment and tools, and perform all operations in connection with and incidental to the complete installation of the mechanical system for the water feature. The work shall include, but not be limited to, the following:

A. Supply and installation of supply and return piping between the sump basin and the water feature.

B. Supply and installation of submersible pump, all piping, valves, and necessary fittings.

C. Coordination with project electrical engineer and general contractor for required electrical service connections at each control system location. Supply and installation of all electrical controls for the pump and automatic level controls.

D. Supply and installation of water feature fittings and balance valves.

E. Supply of an O&M manual for the water feature.

F. Coordination with the general contractor for required connections to the storm sewer for drains and overflows.

G. Coordination with project architect, structural engineer, and general contractor for routing and installation of required piping, fittings, and structural penetrations.

H. Compliance with all local health department codes, regulations, and requirements.

I. Start-up, testing, and training of new system and demonstration of performance to the Owner’s Representative.

J. Replacement of unsatisfactory materials or equipment.

K. Submission of review and record drawings.

L. Submission of all installation, operation, and maintenance manuals.

M. Maintenance period.

N. Guarantee/warranty of equipment.

1.2 SUBMITTALS

Make submittals to the Owner's Representative. Do not commence affected work until the Owner's Representative makes review in writing.

A. Provide single submittal package for review by authorized client representatives, in accordance with General Conditions of project specifications.
B. Shop Drawings: Submit each shop drawing called for in the specifications or installation
details. Show products and materials required for proper installation, their relative locations,
and critical dimensions. Note additions to or modifications from the installation detail.

C. Manufacturer's Data: Submit for approval manufacturer's catalog cuts, specifications, and
operating instructions for all equipment supplied prior to installation.

D. Maintenance Manual: Submit four (4) copies of a bound maintenance manual that includes all
manufacturers' data listed above and recommended operating procedures, adjustments,
system trouble shooting, and preventive maintenance procedures for all equipment supplied.

1.3 RULES AND REGULATIONS

A. Work and materials shall be in accordance with the National Electric Code (Specifically Article
680), Uniform Plumbing Code as published by the Western Plumbing Officials Association,
NEMA, and other applicable state or local laws or regulations. Nothing in these drawings or
specifications is to be construed to permit work that would not conform to these codes.

B. When the construction documents call for materials or construction of a better quality or larger
size than required by the above-mentioned rules and regulations, provide the quality and size
required by the construction documents.

1.4 TESTING AND START-UP

A. Start-Up: When all piping and electrical connections have been completed, the water feature
control system manufacturer's representative shall start, operate, and adjust the mechanical
system to satisfy performance demands as specified. The representative shall conduct 8
hours of training of the operating personnel to familiarize them with the mechanical system
operation, maintenance, and adjustment.

B. Notify the Owner's Representative three days in advance of Start-Up testing.

C. Hydrostatic Pressure Test: Subject all buried piping, valves, and joints to a hydrostatic
pressure equal to twice the shut-off pressure of the pump used.

D. Performance Testing: The complete pump assembly shall operate without vibration throughout
the range of operating conditions. The pump shall be given a running test of normal start and
stop conditions under load.

E. All defects shall be corrected and adjustments made at the expense of the contractor. Tests
shall be repeated until satisfactory results are obtained.

F. Repair or replace faulty equipment or leaks in piping and fitting assemblies. Cement or
caulking to seal leaks is prohibited.

G. Provide a 2 hour training session for maintenance personnel at startup.

1.5 TIME AND COMPLETION

A. Schedule and coordinate the delivery of materials and equipment to achieve the earliest
completion of work within the bounds of construction and progress schedules.
1.6 COORDINATION WITH OTHER SPECIALTIES

A. Obtain copies of the landscape, site utility drawings, electrical drawings, and architectural drawings before commencing with any construction.

B. Coordinate construction with other work to expedite construction schedule and to minimize conflicts between trades.

1.7 GUARANTEE/WARRANTY AND REPLACEMENT

The purpose of this guarantee/warranty is to insure that the Owner receives materials of prime quality, installed and maintained in a thorough and careful manner.

A. For a period of one year from commencement of the formal maintenance period, guarantee/warranty water feature mechanical system equipment and workmanship against defects. Fill and repair depressions. Restore landscape or structural features damaged by the settlement of trenches or excavations. Repair damage to the premises caused by a defective item. Make repairs within seven days of notification from the Owner’s Representative.

B. Contract documents govern replacements identically as with new work. Make replacements at no additional cost to the contract price.

C. Guarantee/warranty applies to originally installed materials and equipment and replacements made during the guarantee/warranty period.

PART 2 – MATERIALS

2.1 QUALITY

Materials used in the system shall be new and without flaws or defects of any type, and shall be the best of their class and kind.

2.2 SUBSTITUTIONS

A. Certain manufacturers and part numbers may be referenced in the construction documents. No substitutions for specified materials will be accepted in the base bid, except where specifically noted in contract documents.

B. Alternative bid proposals which propose a complete prefabricated packaged mechanical and electrical components may be submitted for consideration by the Owner. Alternative proposals must be fully supported by manufacturer's catalog data, tables and/or calculations showing compatibility/comparability with the specified material, and may or may not be approved following the selection of the contractor.

1. Acceptable manufacturers for water feature components:
   c. Engineer approved equal.

C. Provide complete submittals of all manufacturers’ data showing compliance with the Contract Documents.
D. In making a request for a substitution, the Contractor represents that he:
   1. Has investigated the proposed substitution and found that it is the same or better quality, level, capacity, function, or appearance than the specified product, and can demonstrate that to the Engineer.
   2. Will coordinate the installation and make all modifications that may be required for complete installation and operation of the system, without additional cost to the owner.
   3. The Engineer and the Owner will determine acceptability of the proposed substitution and will notify Contractor of acceptance or rejection.

E. Pipe sizes referenced in the construction documents are minimum sizes, and may be increased at the option of the Contractor.

2.3 PIPE, VALVES, AND FITTINGS

A. Supply and Return Pipe and Fittings:
   1. Furnish rigid, unplasticized polyvinyl chloride (PVC) 1120, 1220 National Sanitation Foundation (NSF) approved pipe, extruded from material meeting the requirements of Cell Classification 12454-A or 12454-B, ASTM Standard D1784 for buried pipe installed in landscaped areas outside of the building footprint unless otherwise noted.
      a. Use Schedule 40 PVC conforming to the dimensions and tolerances established by ASTM Standard D2241.
      b. Use solvent weld pipe for all pipe. Use Schedule 40, Type 1, PVC solvent weld fittings conforming to ASTM Standards D2466 and D1784. Use primer approved by the pipe manufacturer. Solvent cement to conform to ASTM Standard D2564.
   2. Joint sealant: Use only Teflon-type tape pipe joint sealant on plastic threads. Use non-hardening, nontoxic pipe joint sealant formulated for use on water-carrying pipes on metal threaded connections.

B. Specialized Pipe and Fittings:
   1. Copper pipe: Type “K” rigid (or soft where specified) conforming to ASTM Standard B88. Fittings shall be wrought copper or cast bronze, soldered or threaded per the installation details. Solder shall be 95% tin and 5% antimony.
   2. Assemblies calling for threaded pipe connections shall utilize PVC Schedule 80 nipples and PVC Schedule 40 threaded fittings.
   3. Use PVC Schedule 80 male adapters for PVC pipe, use copper male adapters or soldered connections for copper pipe.
   4. Use Link Seal or equal for all pipe penetrations through an existing concrete slab or wall.

C. Isolation/Regulating Valves:
   1. For Valve sizes 3-inch and smaller on PVC pipe use full-port ball valve, constructed with bronze body, chrome ball, and TFE seats or Engineer approved equal.

2.1 WATER FEATURE FITTINGS

A. Waterstop Flanges:
   1. Furnish waterstop assembly with NPT male threaded connection and bonding lug for grounding and bonding connection.
   2. Furnish fittings for all pipe penetrations into water feature and sump basin.

B. Water Level Sensor Assembly:
   1. Furnish water level control sensor for water fill on/off, and low water cut-off as shown in the details.
2. Furnish unit constructed with brass, bronze, PVC, and stainless steel components.

3. Furnish water level control panel and solenoid operated water fill valve.

4. Acceptable Model and Manufacturer:
   a. Furnish water level control panel, wire, and all required fittings and hardware as manufactured by Roman Fountains, Inc.

C. Overflow Assembly:
   1. Provide brushed copper standpipe overflow drain as shown in details.

2.2 SUBMERSIBLE PUMP

A. Furnish a 1/3 HP submersible circulation pump constructed with an integral suction screen and a single speed motor. The pump shall be selected to provide a minimum design flow of 35 gallons per minute at 25 feet of head.

B. Furnish a pump with a continuously rising performance curve.

C. Furnish a union and isolation valve downstream of the pump and within the sump basin for removal of pump for winterization, cleaning, and maintenance.

D. Furnish NEMA 4X control enclosure with single phase, 120 volt starter, Hand-Off-Automatic control switch, and 24 VAC control relay for operation of pump.

2.3 CONTROL SYSTEM WIRING

A. Power Wire:
   1. Electric wire from the power source to the water feature controller shall be solid or stranded copper, Type TC Round Jacketed multi conductor cable with ground, direct burial, UL listed. Power wires shall be black, white, and green in color. Size as presented in the drawings. If the control system changes, the Contractor is responsible for verifying that the power wire sizes shown on the drawings are compatible and adequate for the control system being used.
   2. Splices: Use 3M 82-A Series with Split Bolts or Butt Connectors.
   4. Warning tape: Inert plastic film highly resistant to alkalis, acids, or other destructive chemical components likely to be encountered in soils. Three inches wide, colored yellow, and imprinted with "CAUTION: BURIED ELECTRIC LINE BELOW."

B. Control Wire:
   1. Use American Wire Gauge (AWG) No. 14 solid copper, Type UF or PE cable, UL listed for direct underground burial from the satellite control unit to each valve-in-head sprinkler. Common wire: Use American Wire Gauge (AWG) No. 12 solid copper, Type UF or PE cable, UL listed for direct underground burial from the satellite control unit to each valve-in-head sprinkler.
   2. Color: Use white for common ground wire. Use easily distinguished colors for other control wires. Spare control wires shall be of a color different from that of the active control wire. Wire color shall be continuous over its entire length.
   4. Warning tape: Inert plastic film highly resistant to alkalis, acids, or other destructive chemical components likely to be encountered in soils. Three inches wide, colored yellow, and imprinted with "CAUTION: BURIED ELECTRIC LINE BELOW."
PART 3 – EXECUTION

3.1 INSPECTIONS AND REVIEWS

A. Site Inspections:
   1. Verify site conditions and note irregularities affecting work of this section. Report irregularities to the Owner's Representative prior to beginning work.
   2. Beginning work of this section implies acceptance of existing conditions.

B. Utility Locates ("Call Before You Dig"):
   1. Arrange for and coordinate with local authorities the location of all underground utilities.
   2. Repair any underground utilities damaged during construction. Make repairs at no additional cost to the contract price.

C. System Operation and Performance Review: Notify the Owner's Representative two days in advance of review.
   1. Operate pump systems, filter system, water display, and all other components of the system. Verify proper operation of all equipment.
   2. Modifications will be identified by the Owner's Representative.

3.2 EXCAVATION, TRENCHING, AND BACKFILLING

A. Excavate to permit the pipes to be laid at the intended elevations and to permit work space for installing connections and fittings.

B. Minimum cover (distance from top of pipe or control wire to finish grade) is 24-inches over supply and return pipe and over electrical conduit.

C. Backfill only after lines have been reviewed and tested.

D. Excavated material is generally satisfactory for backfill. Backfill shall be free from rubbish, vegetable matter, and stones larger than 2-inches in maximum dimension. Remove material not suitable for backfill. Backfill placed next to pipe shall be free of sharp objects which may damage the pipe.

E. Backfill unsleeved pipe in either of the following manners:
   1. Backfill and puddle the lower half of the trench. Allow to dry 24 hours. Backfill the remainder of the trench in 6-inch layers. Compact to density of surrounding soil.
   2. Backfill the trench by depositing the backfill material equally on both sides of the pipe in 6-inch layers and compacting to the density of surrounding soil.

F. Dress backfilled areas to original grade. Dispose of excess backfill off site.

G. Where utilities conflict with other utility trenching and pipe work, contact the Owner's Representative for trench depth adjustments.

H. Bore for sleeves under obstructions that cannot be removed. Employ equipment and methods designed for horizontal boring.
3.3 ASSEMBLING PIPE AND FITTINGS

A. General:
   2. Keep ends of assembled pipe capped. Remove caps only when necessary to continue assembly.
   3. Trenches may be curved to change direction or avoid obstructions within the limits of the curvature of the pipe. No deflection should occur at a pipe joint.

B. PVC Pipe and Fittings:
   1. Use only strap-type friction wrenches for threaded plastic pipe.
   2. PVC Solvent Weld Pipe:
      a. Use primer and solvent cement. Join pipe in a manner recommended by the manufacturer and in accordance with accepted industry practices.
      b. Cure for 30 minutes before handling and 24 hours before allowing water in pipe.
      c. Snake pipe from side to side within the trench.
   3. Fittings: The use of cross type fittings is not permitted.

C. Specialized Pipe and Fittings
   1. Copper Pipe:
      a. Buff surfaces to be joined to a bright finish. Coat with solder flux.
      b. Solder so that a continuous bead shows around the joint circumference.
   2. Insert a dielectric union wherever a copper-based metal (copper, brass, bronze) and an iron-based metal (iron, galvanized steel, stainless steel) are joined.
   3. PVC Threaded Connections:
      a. Use only factory-formed threads. Field-cut threads are not permitted.
      b. Use only Teflon-type tape.
      c. When connection is plastic-to-metal, the plastic component shall have male threads and the metal component shall have female threads.
   4. Make metal-to-metal, threaded connections with Teflon-type tape or pipe joint compound applied to the male threads only.

3.4 INSTALLATION OF WATER FEATURE FITTINGS

A. Grounding: Insure that all pool fittings and components are properly grounded per NEC article 680.

B. Waterstop Flanges:
   1. Install at all pipe penetrations into pool structures
   2. Install according to manufacturer's details and instructions.

C. Water Level Sensor Assembly:
   1. Install as shown in the details.
   2. Install unit to maintain a water level in the sump basin as shown in the details.
   3. Run control wire and conduit from water level control panel in vault lid to water level sensor in basin.
   4. Install according to manufacturer's details and instructions.
D. Make-up Water Solenoid Valve
   1. Install as shown in the details.
   2. Run control wire and conduit from make-up water solenoid valve to water level control panel in the 022B room in the L0 level of the Bridge Replacement Building.
   3. Ensure backflow preventer is installed upstream of ¾-inch make-up water supply point-of-connection.
   4. Install according to manufacturer's details and instructions.

E. Overflow Assembly:
   1. Install where indicated on the drawings.
   2. Install according to manufacturer’s details and instructions.

3.5 INSTALLATION OF SUBMERSIBLE PUMP

A. Install pump where indicated on drawings. Locate system to ensure proper maintenance access.

B. Anchor submersible pump to the sump basin concrete floor using appropriate anchor bolts and stainless steel hardware.

C. Make piping connections to supply pipe as shown.
   1. Flush all piping prior to operating system.

D. Install per the manufacturer’s recommendations.

E. Operate system and make any necessary adjustments prior to Owner’s review.

3.6 INSTALLATION OF CONTROL SYSTEM WIRING

A. Power Wire:
   1. Route power wire as directed on plans. Install with a minimum number of field splices. If a power wire must be spliced, make splice with recommended connector, installed per wire manufacturer's recommendations. Locate all splices in a separate 12-inch valve box. Coil 4 feet of wire in valve box.
   2. All power wire shall be laid in trenches. The use of a vibratory plow is not permitted.
   3. Green wire shall be used as the common ground wire from power source.
   4. Carefully backfill around power wire to avoid damage to wire insulation or wire connectors.
   5. Install the conduit with a continuous run of warning tape, placed in the backfill, 6-inches above the conduit.

B. Control Wire:
   1. Bundle control wires where two or more are in the same trench. Bundle with pipe wrapping tape spaced at 10-foot intervals.
   2. Control wiring may be chiseled into the soil utilizing a vibratory plow device specifically manufactured for pipe pulling and wire installation. Appropriate chisel must be used so that wire is fed into a chute on the chisel, and wire is not subject to pulling tension. Minimum burial depth must equal minimum cover previously listed.
   3. Provide a 24-inch excess length of wire in an 8-inch diameter loop at each 90 degree change of direction, at both ends of sleeves, and at 100-foot intervals along continuous runs of wiring. Do not tie wiring loop.
4. If a control wire must be spliced, make splice with wire connectors and waterproof sealant, installed per the manufacturer's instructions. Locate splice in a separate 12-inch standard valve box.

5. Protect wire with a continuous run of warning tape placed in the backfill six inches above the wiring.

3.7 INSTALLATION OF OTHER COMPONENTS

A. Tools: Prior to the Pre-Maintenance Review, supply to the Owner operating keys, servicing tools, test equipment, and any other items indicated on the drawings.

B. Other Materials: Install other materials or equipment shown on the drawings or installation details to be part of the mechanical system, even though such items may not have been referenced in these specifications.

3.8 PROJECT RECORD (AS-BUILT) DRAWINGS

A. The Contractor is responsible for documenting changes to the design. Maintain on-site and separate from documents used for construction, one complete set of contract documents as Project Documents. Keep documents current. Do not permanently cover work until as-built information is recorded.

B. Record pipe and wiring network alterations. Record work that is installed differently than shown on the construction drawings. Record accurate reference dimensions, measured from at least two permanent reference points.

C. Prior to construction completion, obtain from the Owner's Representative a reproducible mylar copy of the drawings. Mylars or CAD data files compatible with AutoCAD software, can be purchased from the Engineer. Cost of mylar reproducible drawings or AutoCAD data files on a compact disc is $50 per project set. Using technical drafting pen or CAD, duplicate information contained on the project drawings maintained on site. Label each sheet "Record Drawing".

D. Turn over the "Record Drawings" to the Owner's Representative. Completion of the Record Drawings will be a prerequisite for the Review at the completion of the water feature mechanical system installation.

3.9 MAINTENANCE

A. Upon completion of Final Review, maintain water feature mechanical and control systems for a duration of 30 calendar days. Make periodic examinations and adjustments to the mechanical system components so as to achieve the most desirable operating conditions.

3.10 CLEANUP

A. Upon completion of work, remove from the site all machinery, tools, excess materials, and rubbish.

B. Remove all debris and foreign material from the construction area prior to operating the system.

END OF SECTION 22 52 00
SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION
   A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
      1. Motor controllers.
      2. Torque, speed, and horsepower requirements of the load.
      3. Ratings and characteristics of supply circuit and required control sequence.
      4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS
   A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

   B. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS
   A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

   B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS
   A. Description: NEMA MG 1, Design B, medium induction motor.
B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
   5. Shaft Grounding: Mercotac electrical slip rings or Aegis grounding rings to be installed by motor or equipment manufacturer or installed in the field by contractor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 05 13
SECTION 23 05 14 - VARIABLE-FREQUENCY MOTOR CONTROLLERS FOR HVAC EQUIPMENT [C]

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary
   Conditions and Division 01 Specification Sections, apply to this Section.

1.2 COMPLIANCE WITH SPECIFICATIONS
A. Complete compliance with all requirements of this specification is required. If any supplier takes
   exception to any of the requirements of this specification, the deviations from the specification
   requirements shall be clearly explained on the submittal documents.

1.3 REFERENCES
A. Institute of Electrical and Electronic Engineers:
   1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power
      Circuits.

B. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NEMA FU1 - Low Voltage Cartridge Fuses.
   3. NEMA ICS 7 - Industrial Control and Systems: Adjustable Speed Drives.
   4. NEMA ICS 7.1 – Safety Standards for Construction and Guide for Selection, Installation,
      and Operation of Adjustable Speed Drive Systems.

1.4 SUBMITTALS
A. Submit product data for Variable Frequency Drive (VFD) with bid price. Include manufacturer,
   dimensions, ratings, listings, elementary power and control wiring diagrams and data on
   features and components. Any exceptions to the specification shall be clearly noted in the
   submittal.

B. Submit startup test report.

1.5 WARRANTY
A. The VFD shall be warranted by the manufacturer for a period of 30 months from date of
   shipment. The warranty shall include parts, labor, travel costs, and living expenses incurred by
   the manufacturer to provide factory authorized service.

1.6 QUALITY ASSURANCE
A. The VFD and options shall comply with the applicable requirements of the latest standards of
   ANSI, IEEE, and the National Electrical Code.
B. The VFD and options shall be tested to ANSI/UL Standard 508 and listed by a nationally recognized testing agency such as UL or ETL.

C. To ensure quality and minimize infantile failures at the jobsite, the VFD shall be burned in for 24-hours by the manufacturer.

D. All features shall be functionally tested at the factory for proper operation.

1.7 COORDINATION

A. All VFDs provided for this project shall be from the same manufacturer. Coordinate VFD manufacturer selection among all vendors supplying equipment with VFDs.

1.8 MAINTENANCE MATERIALS

A. Furnish two of each filter.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D
   2. Allen Bradley
   3. ABB
   4. General Electric
   5. Cutler-Hammer
   6. Or approved equal.

B. Furnish complete variable speed drive(s) as specified herein. All standard and optional features requested shall be included within the VFD enclosure unless otherwise specified. Drives shall be for variable torque load, unless otherwise noted.

C. The variable speed drives shall convert three-phase, 60 HZ utility power to adjustable voltage and frequency, three-phase, AC power for step less motor speed control from 10% to 100% of the motor's 60 Hz speed. Input voltage shall be as specified in the schedule.

D. The VFD power input stage shall convert three-phase AC line power to a fixed DC bus voltage. This will be accomplished with a solid state three-phase full-wave diode rectifier with metal oxide varistor (MOV) three-phase protection. Displacement power factor shall not be less than 0.95 throughout the speed range. Input line inductors (3%) shall be included on the line side of the power input state.

E. The VFD output power shall vary frequency to the motor from 6 to 60 Hz with resultant motor speed varying at the motor nameplate rated speed, with output voltage variation from zero to motor rated voltage for optimum volts per hertz (V/Hz) ratio for fan and pump loads. Output current shall be rated 110% of motor full load amps (FLA) for 1 minute based upon VFD's variable torque FLA rating. The output must be a voltage source type generating a sine coded PWM waveform utilizing an asynchronous carrier frequency (output transistor switching
frequency is to be independent of drive output frequency). This carrier frequency shall be adjustable to minimize harmonically induced noise or vibration.

2.2 FEATURES

A. The VFD shall include the following features:
   1. The VFD shall be housed in a NEMA 1 enclosure.
   2. The following display/control parameters shall be located on the front of the enclosure:
      a. Hand/Off/Auto selector to start and stop the motor. In the auto position, the drive shall start/stop from a remote contact closure. In the auto position, motor speed shall be determined by the follower signal. In the manual position, motor speed shall be determined by manual adjustment.
      b. Power on indication that the VFD is being supplied by the power line.
      c. Fault indication that the VFD has tripped on a fault condition.
      d. Display shall indicate load parameters such as load percent, frequency or running load amps.
   3. A set of form C, dry contacts to indicate when the VFD is in the run mode.
   4. A set of form C, dry contacts to indicate when the VFD is in the fault mode.
   5. Terminations for safety interlocks such as freeze and smoke shut-down.
   6. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function shall provide up to 6 programmable restart attempts. The time delay before restart attempts shall be a minimum of 30 seconds. This function permits automatic restarting after the drive controller detects a fault, provided that the other operating functions are correct, a run command is present, and the fault has disappeared. This shall be a function that is field selectable.
   7. The VFD shall include a door interlocked, padlockable, instantaneous-only circuit breaker.
   8. The following bypass features shall be included for fans or pumps that do not have a standby system or standby equipment:
      a. Manual bypass shall provide all the circuitry necessary to transfer the motor from the VFD to the power line, or from the line to the controller while the motor is at zero speed.
      b. The AC Drive shall include mechanically and electrically interlocked isolation and bypass contactors complete with thermal overload relay, VFD/OFF/BYPASS switch and TEST/NORMAL selector switch.
      c. Motor overload protection shall be provided in both the controller mode and the bypass mode.
      d. The operator shall have full control of the bypass starter by operation of the VFD/OFF/BYPASS selector switch.
      e. In the AUTOMATIC mode of operation the isolation and bypass contactors shall be sequenced by the 110 volt rated auto start contact provided by user.
      f. A TEST/NORMAL selector switch shall provide test operation of the power converter while operating the motor in bypass.
      g. A pilot light shall indicate whether motor is operating in drive or bypass mode.
   9. Speed Reference Input: Shall accept both a manual speed signal and a 0-10 VDC speed reference analog input signal from the Building Automation System (BAS).
   10. Feedback Signal: Provide 0-5 VDC or 0-20 mA analog output signal to indicate actual operating speed of VFD. Output signal shall be fed into the BAS.

2.3 PROTECTIVE FEATURES

A. The VFD shall include the following protective features:
   1. Protection against input transient voltage spikes.
2. Separate overload protection for each motor controlled.
3. Protection against input power under voltage, over voltage, and phase loss.
4. Protection against output current overload and over current.
5. Protection against over temperature within the VFD enclosure.
6. Protection against over voltage on the DC bus.
7. DC bus discharge circuit for protection of service personnel.
8. Insensitive to incoming power phase sequence.

2.4 ADJUSTMENTS:

A. The VFD shall include the following adjustments inside the enclosure:
   1. Maximum speed, adjustable 50-100% base speed.
   2. Minimum speed, adjustable 0-50% base speed.
   3. Acceleration time, adjustable 3 to 1800 seconds.
   4. Deceleration time, adjustable 3 to 1800 seconds with override circuit to prevent nuisance trips if decel time is set too short.
   5. Current limit, adjustable 0-100%.

2.5 SERVICE CONDITIONS

A. The VFD shall be designed to operate within the following service conditions:
   1. Ambient temperature, 0-40°C (32 to 104°F).
   2. 0 to 95% relative humidity, non-condensing.
   3. Elevation to 1,000 meters (3,300 feet) without derating.
   4. AC line voltage variation, -10% to +10% of nominal.

PART 3 - EXECUTION

3.1 START UP SERVICE:

A. The manufacturer shall provide start up service by a factory trained service technician. The service technician shall verify correct installation, start up the drive, and check for proper operation.

3.2 TESTING

A. After check out and start up of drive(s) by manufacturer, the University will monitor the voltage and current percent Total Harmonic Distortion (THD) at the input of each drive installed. The Electrical Contractor shall provide manpower to assist the University with the operation of the drives during testing.

3.3 TRAINING

A. The manufacturer shall have regularly scheduled maintenance and training schools on the equipment supplied.

END OF SECTION 23 05 14
SECTION 23 05 16 - EXPANSION LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Pipe loops and swing connections.
   2. Alignment guides and anchors.

1.3 PERFORMANCE REQUIREMENTS
A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

PART 2 - PRODUCTS

2.1 ALIGNMENT GUIDES AND ANCHORS
A. Alignment Guides:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Flex-Hose Co., Inc.
      b. Metraflex, Inc.
   2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:
   1. Steel Shapes and Plates: ASTM A 36/A 36M.
   2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
   4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

PART 3 - EXECUTION

3.1 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.

B. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.

C. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.2 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:


2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.

2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 23 05 16
SECTION 23 05 17 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Sleeves.
   2. Stack-sleeve fittings.
   3. Sleeve-seal systems.

PART 2 - PRODUCTS

2.1 SLEEVES
A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends. (For exterior walls.)
B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint. (For interior use only.)
C. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.
2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Advance Products & Systems, Inc.
2. Metraflex Company (The).
3. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Plastic.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 GROUT


B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.
   1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
   3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
   4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

END OF SECTION 23 05 17
SECTION 23 0518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Escutcheons.
   2. Floor plates.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with rough-brass finish.
   f. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with rough-brass finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 23 05 18
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Bimetallic-actuated thermometers.
   2. Liquid-in-glass thermometers.
   3. Dial-type pressure gages.
   4. Gage attachments.
   5. Test plugs.
   6. Venturi flowmeters.
B. Related Sections:
   1. Division 23 Section "Steam and Condensate Heating Piping" for steam and condensate meters.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Ashcroft Inc.
2. Ernst Flow Industries.
3. Marsh Bellofram.
5. Trerice, H. O. Co.
6. Weiss Instruments, Inc.


C. Case: Liquid-filled type(s); stainless steel with 5-inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.

E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

H. Window: Plain glass.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Miljoco Corporation.
   b. Trerice, H. O. Co.
   c. Weiss Instruments, Inc.


3. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.

4. Case Form: Adjustable angle unless otherwise indicated.

5. Tube: Glass with magnifying lens and red organic liquid.

6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.

7. Window: Glass.

8. Stem: Aluminum and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.

10. **Accuracy:** Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

### 2.3 DUCT-THERMOMETER MOUNTING BRACKETS

A. **Description:** Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

### 2.4 PRESSURE GAGES

A. **Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:**

1. **Basis-of-Design** is “Quality” series gage as manufactured by Marsh Instrument Company. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   
   a. AMETEK, Inc.; U.S. Gauge.
   b. Trerice, H. O. Co.
   c. Weiss Instruments, Inc.

2. **Standard:** ASME B40.100.
3. **Case:** Liquid-filled type(s); Stainless steel; 4-1/2-inch nominal diameter, except for in mechanical spaces which shall utilize 6-inch nominal diameter on steam and condensate systems.
4. **Pressure-Element Assembly:** Bourdon tube unless otherwise indicated.
5. **Pressure Connection:** Brass, with NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. **Movement:** Mechanical, with link to pressure element and connection to pointer.
7. **Dial:** Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. **Pointer:** Dark-colored metal.
9. **Window:** Glass.
10. **Ring:** Stainless steel.
11. **Accuracy:** Grade A, plus or minus 1 percent of middle half of scale range.

### 2.5 GAGE ATTACHMENTS

A. **Snubbers:** ASME B40.100, brass; with NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. **Siphons:** Loop-shaped section of steel pipe with NPS 1/2 pipe threads.

C. **Valves:** Brass or stainless-steel needle, with NPS 1/2, ASME B1.20.1 pipe threads.

### 2.6 TEST PLUGS

A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Miljoco Corporation.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: EPDM self-sealing rubber.

2.7 FLOWMETERS

A. Venturi Flowmeters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. ABB; Instrumentation and Analytical.
   b. Gerand Engineering Co.
   c. Hyspan Precision Products, Inc.
   d. Preso Meters; a division of Racine Federated Inc.
   e. S. A. Armstrong Limited; Armstrong Pumps Inc.
   f. Victaulic Company.

2. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.

3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.

   a. Design: Differential-pressure-type measurement for water.
   b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
   d. Minimum Temperature Rating: 250 deg F.
   e. End Connections for NPS 2 and Smaller: Threaded.
   f. End Connections for NPS 2-1/2 and Larger: Flanged or welded.
   g. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.

5. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch-diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
   a. Scale: Gallons per minute.
   b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.

6. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected flowmeter element and having two 12-foot hoses, with carrying case.
   a. Scale: Gallons per minute.
   b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.
7. Display: Shows rate of flow, with register to indicate total volume in gallons.
9. Operating Instructions: Include complete instructions with each flowmeter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
B. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
C. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
D. Install valve and snubber in piping for each pressure gage for fluids (except steam).
E. Install valve and syphon fitting in piping for each pressure gage for steam.
F. Install test plugs in piping tees.
G. Install flow indicators in piping systems in accessible positions for easy viewing.
H. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
I. Install flowmeter elements in accessible positions in piping systems.
J. Install permanent indicators on walls or brackets in accessible and readable positions.
K. Install connection fittings in accessible locations for attachment to portable indicators.
L. Install thermometers in the following locations:
   1. Inlet and outlet of each hydronic coil in air-handling units.
   2. Inlets and Outlets of each hydronic heat exchanger.
   3. Outside-, return-, supply-, and mixed-air ducts.
   5. Steam service entrance to the building.
   6. Condensate service exit from the building.
M. Install pressure gages in the following locations:
   1. Suction and discharge of each pump.
   2. Steam service entrance to the building.
   3. Condensate service exit from the building.
   4. Expansion Tank connection to water system.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
B. Connect flowmeter-system elements to meters.
C. Connect flowmeter transmitters to meters.

3.3 ADJUSTING
A. After installation, calibrate meters according to manufacturer's written instructions.
B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE
A. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems, each steam-to-hot water heat exchanger, utility service entrance shall be the following:
   1. Industrial-style, liquid-in-glass type.
B. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be the following:
   1. Liquid-filled, bimetallic-actuated type.
C. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE
A. Scale Range for Chilled-Water Piping: 0 to 100 deg F.
B. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F.
C. Scale Range for Steam and Steam-Condensate Piping: 50 to 400 deg F.
D. Scale Range for Air Ducts: 30 to 240 deg F.

3.6 PRESSURE-GAGE SCHEDULE
A. Pressure gages at suction and discharge of each pump shall be the following:
   1. Liquid-filled, direct-mounted, metal case.
   2. Test plug with EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE
A. Scale Range for Chilled-Water Piping: 0 to 100 psi.
B. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.
C. Scale Range for Steam Piping: 0 to 30 psi.

3.8 FLOWMETER SCHEDULE
A. Flowmeters for Chilled-Water Piping: Venturi type.
B. Flowmeters for Heating, Hot-Water Piping: Venturi type.

END OF SECTION 23 05 19
SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Brass ball valves.
   2. Bronze ball valves.
   3. Iron ball valves.
   5. Bronze swing check valves.
   8. Iron, plate-type check valves.
  10. Iron gate valves.
  13. Chainwheels.

B. Related Sections:
   1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
   2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stem.
G. SWP: Steam working pressure.
1.4 ACTION SUBMITTALS
   A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE
   A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
   B. ASME Compliance:
      1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
      2. ASME B31.1 for power piping valves.
      3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Prepare valves for shipping as follows:
      1. Protect internal parts against rust and corrosion.
      2. Protect threads, flange faces, grooves, and weld ends.
      3. Set angle, gate, and globe valves closed to prevent rattling.
      4. Set ball and plug valves open to minimize exposure of functional surfaces.
      5. Set butterfly valves closed or slightly open.
      6. Block check valves in either closed or open position.
   B. Use the following precautions during storage:
      1. Maintain valve end protection.
      2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
   C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. All valves for this project shall be from one manufacturer. Multiple manufacturers are listed to provide the contractor with the ability to competitively price the project, but is not to allow the contractor to use more than one manufacturer on the project.
   B. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
      1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2.2 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
   2. Handwheel: For valves other than quarter-turn types.
   3. Handlever: For quarter-turn valves NPS 6 and smaller.
   4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   1. Gate Valves: With rising stem.
   2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Grooved: With grooves according to AWWA C606.
   4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
   1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. NIBCO INC.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Two piece.
      e. Body Material: Bronze.
      f. Ends: Threaded.
2.4 IRON BALL VALVES

A. Class 125, Iron Ball Valves:

1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   b. CWP Rating: 200 psig.
   d. Body Material: ASTM A 126, gray iron.
   e. Ends: Flanged.
   f. Seats: PTFE or TFE.
   g. Stem: Stainless steel.
   h. Ball: Stainless steel.
   i. Port: Full.

2.5 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Class 150, Single-Flange, High-Performance Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Flowseal.
   b. NIBCO INC.

2. Description:
   a. Standard: MSS SP-68.
   b. CWP Rating: 285 psig at 100 deg F.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
   e. Seat: Reinforced PTFE or metal.
   f. Stem: Stainless steel; offset from seat plane.
   g. Disc: Carbon steel.
   h. Service: Bidirectional.
2.6 **BRONZE SWING CHECK VALVES**

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   
a. Crane Co.; Crane Valve Group; Crane Valves.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 200 psig.
   c. Body Design: Horizontal flow.
   e. Ends: Threaded.
   f. Disc: Bronze.

2.7 **IRON SWING CHECK VALVES**

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   
a. Crane Co.; Crane Valve Group; Crane Valves.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   a. Standard: MSS SP-71, Type I.
   b. CWP Rating: 200 psig.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.
   g. Gasket: Asbestos free.

2.8 **IRON, CENTER-GUIDED CHECK VALVES**

A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. NIBCO INC.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
   c. NPS 14 to NPS 24, CWP Rating: 150 psig.
   d. Body Material: ASTM A 126, gray iron.
   e. Style: Compact wafer.
   f. Seat: Bronze.

B. Class 125, Iron, Dual-Plate Check Valves with Metal Seat:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. NIBCO INC.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
      c. NPS 14 to NPS 24, CWP Rating: 150 psig.
      e. Body Material: ASTM A 126, gray iron.
      f. Seat: Bronze.

2.9 BRONZE GATE VALVES

A. Class 125, RS Bronze Gate Valves:
   1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. NIBCO INC.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-80, Type 2.
      b. CWP Rating: 200 psig.
      d. Ends: Threaded or solder joint.
      e. Stem: Bronze.
      f. Disc: Solid wedge; bronze.
      g. Packing: Asbestos free.
      h. Handwheel: Malleable iron, bronze, or aluminum.
2.10 IRON GATE VALVES

A. Class 125, OS&Y, Iron Gate Valves:

1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-70, Type I.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM A 126, gray iron with bolted bonnet.
   d. Ends: Flanged.
   e. Trim: Bronze.
   f. Disc: Solid wedge.
   g. Packing and Gasket: Asbestos free.

2.11 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   d. Ends: Threaded or solder joint.
   e. Stem and Disc: Bronze.
   f. Packing: Asbestos free.
   g. Handwheel: Malleable iron, bronze, or aluminum.

2.12 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:

1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for ball butterfly gate and globe valves NPS 4 and larger and more than 72 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.
3.3 **ADJUSTING**

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 **GENERAL REQUIREMENTS FOR VALVE APPLICATIONS**

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly, or gate valves.
4. Pump-Discharge Check Valves:
   a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
   b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal-seat check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 **CHILLED-WATER VALVE SCHEDULE**

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, brass with stainless-steel trim.
3. Bronze Swing Check Valves: Class 125, bronze disc.
4. Bronze Gate Valves: Class 125, RS, bronze.
5. Bronze Globe Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves, NPS 2-1/2 to NPS 6: Class 150.
3. High-Performance Butterfly Valves: Class 150, single flange.
4. Iron Swing Check Valves: Class 125, metal seats.
5. Iron, Center-Guided Check Valves, NPS 2-1/2 to NPS 24: Class 125, metal seat.
6. Iron, Plate-Type Check Valves: Class 125; dual plate; metal seat.
7. Iron Gate Valves: Class 125, OS&Y

3.6 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
   3. Bronze Swing Check Valves: Class 125, bronze disc.
   4. Bronze Gate Valves: Class 125, RS.
   5. Bronze Globe Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
   2. Iron Ball Valves, NPS 2-1/2 to NPS 4: Class 150.
   3. Iron Swing Check Valves: Class 125, metal seats.
   4. Iron, Center-Guided Check Valves, NPS 2-1/2 to NPS 24: Class 125, metal seat.
   5. Iron, Plate-Type Check Valves: Class 125; dual plate; metal seat.
   6. Iron Gate Valves: Class 125, OS&Y.

3.7 LOW-PRESSURE STEAM VALVE SCHEDULE (15 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:
   1. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
   2. Bronze Gate Valves: Class 125, RS.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
   2. Iron Ball Valves, NPS 2-1/2 to NPS 6: Class 150.
   3. High-Performance Butterfly Valves: Class 150, single flange.
   4. Iron Gate Valves: Class 125, OS&Y.
   5. Iron Globe Valves, NPS 2-1/2 to NPS 6: Class 125.

3.8 STEAM-CONDENSATE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
   2. Bronze Swing Check Valves: Class 125, bronze disc.
   3. Bronze Gate Valves: Class 125, RS.
   4. Bronze Globe Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron Valves: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves: Class 150.
3. High-Performance Butterfly Valves: Class 150, single flange.
4. Iron Swing Check Valves: Class 125, metal seats.
5. Iron Gate Valves: Class 125, OS&Y.

END OF SECTION 23 05 23
SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.

B. Related Sections:
1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 23 Section "Vibration Controls for HVAC Piping and Equipment" for vibration isolation devices.
3. Division 23 Section "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS
A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS
A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.6 QUALITY ASSURANCE
PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

B. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Carpenter & Paterson, Inc.
   3. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
   4. Piping Technology & Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
2.4 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

K. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8: 24 inches long and 0.075 inch thick.
   5. Pipes NPS 8: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
   6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.3 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.5 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

D. Use carbon-steel pipe hangers and supports and attachments for general service applications.

E. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

F. Use padded hangers for piping that is subject to scratching.

G. Use thermal-hanger shield inserts for insulated piping and tubing.
H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
8. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
9. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
10. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. C-Clamps (MSS Type 23): For structural shapes.
6. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
7. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
8. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
a. Light (MSS Type 31): 750 lb.
b. Medium (MSS Type 32): 1500 lb.
c. Heavy (MSS Type 33): 3000 lb.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29
SECTION 23 05 48 - VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Housed spring mounts.
2. Elastomeric hangers.
3. Spring hangers.
4. Pipe riser resilient supports.

1.3 DEFINITIONS

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.
1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
4. Isolation Technology, Inc.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.

B. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.

1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
2. Base: Factory drilled for bolting to structure.
3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.

C. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

D. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

E. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- thick neoprene. Include steel and neoprene vertical-limit
stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

F. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by.

B. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

C. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
   2. The contractor shall hire a third-party vibration analyst to conduct baseline vibration signature tests of all rotating machinery.
   3. This Third-party Vibration Contractor shall collect from the Mechanical Contractor the various manufacturer’s recommended vibration levels.
   4. The Vibration Contractor shall utilize an accelerometer to determine the vibration levels of all rotating machinery and equipment.
   5. Vibration pick-ups shall be placed on bearing caps on the horizontal, vertical, and axial directions, or on the equipment supporting structure if the bearing caps are concealed.
   6. The University’s Commissioning Agent shall witness and/or verify the accuracy of the test results of the Vibration Contractor’s test results.
   7. All equipment while operating shall not exceed a self-excite RMS radial velocity of greater than 0.10 inches/second.
   8. Where equipment exceeds the manufacturer’s recommended levels or the levels specified, the Contractor shall make corrections to reduce the vibration frequencies and amplitudes to meet the recommendations.
   9. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days’ advance notice.
  11. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  12. Test to 90 percent of rated proof load of device.
  14. Measure isolator deflection.
  15. Verify snubber minimum clearances.
  16. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust isolators after piping system is at operating weight.
B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 23 05 48
SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Equipment labels.
      2. Pipe labels.
      3. Duct labels.
      4. Valve tags.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
   C. Valve numbering scheme.
   D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION
   A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
   B. Coordinate installation of identifying devices with locations of access panels and doors.
   C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS
   A. Labels for Equipment:
      1. Material and Thickness: Black micarta laminate, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2 by 1 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE AND DUCT LABELS

A. General Requirements for Manufactured Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Self-Adhesive Labels: Printed vinyl-backed cloth with contact-type, permanent-adhesive backing.

C. Label Contents: Include identification of service using same designations or abbreviations as used on Drawings, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: 1-inch x 2-inch black micarta laminated tags, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: 10-gauge Brass S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag, and in accordance with design drawing abbreviations), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.
2. Valve schedule shall be mounted in a glass-front frame.

PART 3 - EXECUTION
3.1 PREPARATION
A. Clean piping and equipment surfaces of substances that could impair bond of paint, identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 Pipe and Equipment Color Coding
A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting." Paint the piping as indicated below:
   1. Chilled Water: Green with White band.
   2. Heating Hot Water: Green
   3. Refrigerant: Yellow with Black bands
   4. Steam: Yellow.
   5. Condensate: Green with red band.
   6. Drain lines: Aluminum with red bands.

B. Equipment Color-Coding:

3.3 EQUIPMENT LABEL INSTALLATION
A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

C. For equipment in finished areas the equipment tags shall be located inside an access door.

3.4 PIPE LABEL INSTALLATION
A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 15 feet along each run.

B. Pipe Label Color Schedule:
   1. Low Pressure Steam:
      a. Background Color: Yellow.
      b. Letter Color: Black.
2. Chilled, Heating Hot Water, and Condensate Piping:
   a. Background Color: Green.
   b. Letter Color: Black.

3. Refrigerant Piping:
   a. Background Color: Yellow.
   b. Letter Color: Black.

3.5 DUCT LABEL INSTALLATION
1. Install self-adhesive duct labels with permanent adhesive on air ducts.

   B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 15 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE-TAG INSTALLATION

   A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

   B. Valve-Tag Application Schedule: Tag all valves as indicated below:

      1. Valve-Tag Size and Shape: 1 inch x 2 inch
      2. Valve-Tag Color: Black
         a. Letter Color: White

END OF SECTION 23 05 53
SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Balancing Air Systems:
      a. Constant-volume air systems.
      b. Variable-air-volume systems.
   2. Balancing Hydronic Piping Systems:
      a. Variable-flow hydronic systems.

1.3 ACTION SUBMITTALS
A. LEED Submittals:
   1. Air-Balance Report for Prerequisite IEQ 1: Documentation of work performed for ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
   2. TAB Report for Prerequisite EA 2: Documentation of work performed for ASHRAE/IESNA 90.1,Section 6.7.2.3 - "System Balancing."

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
B. Certified TAB reports.
C. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.5 QUALITY ASSURANCE
A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC NEBB or TABB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC NEBB or TABB as a TAB technician.

B. TAB Conference: Meet with Construction Manager and Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:
   b. The TAB plan.
   c. Coordination and cooperation of trades and subcontractors.
   d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 PROJECT CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems’ designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section “Metal Ducts” and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.
O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.
C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 Section “Metal Ducts.”

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

   a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

   a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

   a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.

5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.
   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

   a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

   a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.

8. Record final fan-performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Balance variable-air-volume systems the same as described for constant-volume air systems.
2. Set terminal units and supply fan at full-airflow condition.
3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
4. Readjust fan airflow for final maximum readings.
5. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.
6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

   a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

   a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.

3. Set terminal units at full-airflow condition.

4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.

5. Adjust terminal units for minimum airflow.

6. Measure static pressure at the sensor.

7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Set variable frequency drive control to meet design conditions rather than using balancing valves to impose pressure drop.

B. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.9 PROCEDURES FOR HEAT EXCHANGERS

A. Measure water flow through all circuits.
B. Adjust water flow to within specified tolerances.
C. Measure inlet and outlet water temperatures.
D. Measure inlet steam pressure.
E. Check settings and operation of safety and relief valves. Record settings.

3.10 PROCEDURES FOR MOTORS
A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer's name, model number, and serial number.
   4. Efficiency rating.
   5. Nameplate and measured voltage, each phase.
   6. Nameplate and measured amperage, each phase.
   7. Starter thermal-protection-element rating.
B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.11 PROCEDURES FOR CONDENSING UNITS
A. Verify proper rotation of fans.
B. Measure entering- and leaving-air temperatures.
C. Record compressor data.

3.12 PROCEDURES FOR HEAT-TRANSFER COILS
A. Measure, adjust, and record the following data for each water coil:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.
   4. Dry-bulb temperature of entering and leaving air.
   5. Wet-bulb temperature of entering and leaving air for cooling coils.
   6. Airflow.
   7. Air pressure drop.
B. Measure, adjust, and record the following data for each refrigerant coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Wet-bulb temperature of entering and leaving air.
   3. Airflow.
   4. Air pressure drop.
   5. Refrigerant suction pressure and temperature.
3.13 **TOLERANCES**

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans:  Plus or minus 10 percent.
2. Air Outlets and Inlets:  Plus or minus 10 percent.
3. Heating-Water Flow Rate:  Plus or minus 10 percent.
4. Cooling-Water Flow Rate:  Plus or minus 10 percent.

3.14 **REPORTING**

A. Initial Construction-Phase Report:  Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices.  Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing.  Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports:  Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures.  Include a list of deficiencies and problems found in systems being tested and balanced.  Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.15 **FINAL REPORT**

A. General:  Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents:  In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers’ test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data:  In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
   a. Indicated versus final performance.
   b. Notable characteristics of systems.
   c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
   a. Settings for outdoor-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Cooling coil, wet- and dry-bulb conditions.
   d. Face and bypass damper settings at coils.
   e. Fan drive settings including settings and percentage of maximum pitch diameter.
   f. Inlet vane settings for variable-air-volume systems.
   g. Settings for supply-air, static-pressure controller.
   h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
   1. Quantities of outdoor, supply, return, and exhaust airflows.
   2. Water and steam flow rates.
   3. Duct, outlet, and inlet sizes.
   4. Pipe and valve sizes and locations.
   5. Terminal units.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Make and type.
      d. Model number and unit size.
      e. Manufacturer's serial number.
      f. Unit arrangement and class.
      g. Discharge arrangement.
      h. Sheave make, size in inches, and bore.
      i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
      j. Number, make, and size of belts.
      k. Number, type, and size of filters.
   2. Motor Data:
      a. Motor make, and frame type and size.
      b. Horsepower and rpm.
      c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
   a. Total air flow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Preheat-coil static-pressure differential in inches wg.
   g. Cooling-coil static-pressure differential in inches wg.
   h. Heating-coil static-pressure differential in inches wg.
   i. Outdoor airflow in cfm.
   j. Return airflow in cfm.
   k. Outdoor-air damper position.
   l. Return-air damper position.
   m. Vortex damper position.

F. Apparatus-Coil Test Reports:
   1. Coil Data:
      a. System identification.
      b. Location.
      c. Coil type.
      d. Number of rows.
      e. Fin spacing in fins per inch o.c.
      f. Make and model number.
      g. Face area in sq. ft.
      h. Tube size in NPS.
      i. Tube and fin materials.
      j. Circuiting arrangement.

   2. Test Data (Indicated and Actual Values):
      a. Air flow rate in cfm.
      b. Average face velocity in fpm.
      c. Air pressure drop in inches wg.
      d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
      e. Return-air, wet- and dry-bulb temperatures in deg F.
      f. Entering-air, wet- and dry-bulb temperatures in deg F.
      g. Leaving-air, wet- and dry-bulb temperatures in deg F.
      h. Water flow rate in gpm.
      i. Water pressure differential in feet of head or psig.
      j. Entering-water temperature in deg F.
      k. Leaving-water temperature in deg F.
      l. Refrigerant expansion valve and refrigerant types.
      m. Refrigerant suction pressure in psig.
      n. Refrigerant suction temperature in deg F.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
   1. Fan Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft.
g. Indicated air flow rate in cfm.
h. Indicated velocity in fpm.
i. Actual air flow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

I. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):
   a. Air flow rate in cfm.
   b. Air velocity in fpm.
   c. Preliminary air flow rate as needed in cfm.
   d. Preliminary velocity as needed in fpm.
   e. Final air flow rate in cfm.
   f. Final velocity in fpm.
   g. Space temperature in deg F.

J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
   a. System and air-handling-unit identification.
   b. Location and zone.
   c. Room or riser served.
   d. Coil make and size.
   e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
   a. Air flow rate in cfm.
   b. Entering-water temperature in deg F.
   c. Leaving-water temperature in deg F.
   d. Water pressure drop in feet of head or psig.
   e. Entering-air temperature in deg F.
   f. Leaving-air temperature in deg F.

K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and size.
   e. Model number and serial number.
   f. Water flow rate in gpm.
   g. Water pressure differential in feet of head or psig.
   h. Required net positive suction head in feet of head or psig.
   i. Pump rpm.
   j. Impeller diameter in inches.
   k. Motor make and frame size.
   l. Motor horsepower and rpm.
   m. Voltage at each connection.
   n. Amperage for each phase.
   o. Full-load amperage and service factor.
   p. Seal type.

2. Test Data (Indicated and Actual Values):
a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

L. Instrument Calibration Reports:
   1. Report Data:
      a. Instrument type and make.
      b. Serial number.
      c. Application.
      d. Dates of use.
      e. Dates of calibration.

3.16 INSPECTIONS

A. Initial Inspection:
   1. After testing and balancing are complete, operate each system and randomly check
      measurements to verify that the system is operating according to the final test and
      balance readings documented in the final report.
   2. Check the following for each system:
      a. Measure airflow of at least 10 percent of air outlets.
      b. Measure water flow of at least 5 percent of terminals.
      c. Measure room temperature at each thermostat/temperature sensor. Compare the
         reading to the set point.
      d. Verify that balancing devices are marked with final balance position.
      e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:
   1. After initial inspection is complete and documentation by random checks verifies that
      testing and balancing are complete and accurately documented in the final report,
      request that a final inspection be made by Commissioning Authority.
   2. The TAB contractor's test and balance engineer shall conduct the inspection in the
      presence of Commissioning Authority.
   3. Commissioning Authority shall randomly select measurements, documented in the final
      report, to be rechecked. Rechecking shall be limited to either 10 percent of the total
      measurements recorded or the extent of measurements that can be accomplished in a
      normal 8-hour business day.
   4. If rechecks yield measurements that differ from the measurements documented in the
      final report by more than the tolerances allowed, the measurements shall be noted as
      "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.17 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply, return, and relief air.
2. Indoor, exposed ductwork within mechanical rooms (all duct services except exhaust).

B. Related Sections:

1. Division 23 Section "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
1.6 DELIVERY, STORAGE, AND HANDLING
   A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION
   A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
   B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
   C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING
   A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
   B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS
   A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and articles for where insulating materials shall be applied.
   B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
   C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
   D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
   E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
      1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
         a. CertainTeed Corp.; SoftTouch Duct Wrap.
         b. Johns Manville; Microlite.
         c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

F. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. CertainTeed Corp.; Commercial Board.
   b. Fibrex Insulations Inc.; FBX.
   c. Johns Manville; 800 Series Spin-Glas.
   d. Knauf Insulation; Insulation Board.
   e. Manson Insulation Inc.; AK Board.
   f. Owens Corning; Fiberglas 700 Series.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. CertainTeed Corp.; FlameChek.
   b. Johns Manville; Firetemp Wrap.
   c. Thermal Ceramics; FireMaster Duct Wrap.
   d. 3M; Fire Barrier Wrap Products.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   b. Eagle Bridges - Marathon Industries; 550.
   e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lb/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
2. Width: 3 inches.
3. Thickness: 6.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.8 SECUREMENTS

A. Bands:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; CHP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.

3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
a. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. AGM Industries, Inc.; RC-150.
2. GEMCO; R-150.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. **Staples:** Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

D. **Wire:** 0.062-inch soft-annealed, stainless steel.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:


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**PART 3 - EXECUTION**

3.1 **EXAMINATION**

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 **PREPARATION**

A. **Surface Preparation:** Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 **GENERAL INSTALLATION REQUIREMENTS**

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire
damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper
sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper
sleeves and externally insulate damper sleeve beyond floor to match adjacent duct
insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in
Division 07 Section "Penetration Firestopping."

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit
area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and
transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head,
capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of
vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal
centerline of duct. Space 3 inches maximum from insulation end joints, and 16
inches o.c.
   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c.
each way, and 3 inches maximum from insulation joints. Install additional pins to
hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and
plenums.
   d. Do not overcompress insulation during installation.
   e. Impale insulation over pins and attach speed washers.
   f. Cut excess portion of pins extending beyond speed washers or bend parallel with
insulation surface. Cover exposed pins and washers with tape matching insulation
facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous
unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with
insulation by removing 2 inches from one edge and one end of insulation segment.
Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch
o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-
barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-
barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot
intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped
pattern over insulation face, along butt end of insulation, and over the surface.
Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

   b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

   d. Do not overcompress insulation during installation.

   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply, return, relief and outdoor air.
2. Indoor, exposed supply, return, relief and outdoor air.
3. All outside air duct within the building is exposed within mechanical spaces.
4. The only duct not requiring insulation is exhaust duct.

B. Items Not Insulated:

1. Exhaust ducts.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and rectangular supply, return, and relief air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft nominal density.

B. Exposed, round and rectangular air duct and plenum insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft nominal density.

C. Exposed, outdoor-air duct and plenum insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft nominal density.

END OF SECTION 23 07 13
SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:
   1. Condensate drain piping, indoors.
   2. Chilled-water piping, indoors.
   3. Heating hot-water piping, indoors.
   4. Steam and steam condensate piping, indoors.

B. Related Sections:
   1. Division 23 Section "Duct Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

1.4 INFORMATIONAL SUBMITTALS

A. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to
authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS


B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000-Degree Pipe Insulation.
   d. Manson Insulation Inc.; Alley-K.
   e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS


1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Ramco Insulation, Inc.; Super-Stik.


1. Products: Subject to compliance with requirements, [available products that may be incorporated into the Work include, but are not limited to, the following]:
   a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).


1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   b. Eagle Bridges - Marathon Industries; 550.
   e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.

2.5 SEALANTS

A. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      b. Vimasco Corporation; Elastafab 894.

2.8 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

2.9 TAPES
A. **ASJ Tape:** White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. **Width:** 3 inches.
3. **Thickness:** 11.5 mils.
4. **Adhesion:** 90 ounces force/inch in width.
5. **Elongation:** 2 percent.
6. **Tensile Strength:** 40 lbf/inch in width.
7. **ASJ Tape Disks and Squares:** Precut disks or squares of ASJ tape.

### 2.10 SECUREMENTS

A. **Bands:**

1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. **Stainless Steel:** ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch minimum wide with wing seal or closed seal.
3. **Aluminum:** ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch minimum wide with wing seal or closed seal.
4. **Springs:** Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. **Staples:** Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. **Wire:** 0.062-inch soft-annealed, galvanized steel.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   5. Handholes.
   6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.7 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

   1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

   1. All Pipe Sizes: Insulation shall be the following:

      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

B. Chilled Water:

   1. NPS 3 and Smaller: Insulation shall be one of the following:

      b. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

   2. NPS 4 to NPS 12: Insulation shall be one of the following:

      b. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches thick.

C. Heating-Hot-Water Supply and Return, 200 Deg F and Below:
1. NPS 6 and Smaller: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

D. Steam and Steam Condensate, 350 Deg F and Below:

1. NPS 1 and Larger: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I or II: 3 inches thick.
   2. Equipment needing service such as steam traps, heat exchangers, control valves, etc:
      a. Removable-reusable Insulation Covers, material appropriate for application, Ohio Valley Industrial Services (www.ovisinc.com), or equal.

END OF SECTION 23 07 19
SECTION 23 08 00 – HVAC SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Systems and equipment Start-Up and Functional Performance Testing.
B. Validation of proper and thorough installation of Division 23 systems and equipment.
C. Generic Start-Up Documentation for mechanical systems and equipment.
D. Development of final Start-Up Documentation for mechanical systems and equipment.
E. System Start-Up and Turn-Over procedures.
F. Systems balancing verification.
G. Coordination and execution of Training Events.

1.2 GENERAL DESCRIPTION

A. Commissioning (Cx) is the process of ensuring that (i) all building systems are installed and perform interactively according to the design intent; (ii) that systems are efficient and cost effective and meet the Owner’s operational needs; (iii) that the installation is accurately documented; and (iv) that the Operators are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems, and establishes testing and communication protocols to advance the building systems from installation to optimized, fully-dynamic operation.

B. Commissioning Authority (CxA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.

C. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.

D. This Section outlines the Cx procedures specific to the Division 23 Contractors. Requirements common to all Sections are specified in Section 01 91 00 and Section 01 91 10. This Section and other sections of the specification details the Contractor’s responsibilities relative to the Cx process.

1.3 SCOPE

A. The following systems and equipment are included in the Scope of Commissioning for this project:

B. Mechanical/HVAC Systems: All Division 23 equipment and systems are subject to commissioning, including but not limited to the systems listed below. All components and devices (sensors, valves, etc.) that make up these systems are included.
   1. Air Handling Units (AHU)
   2. VAV terminal units
   3. Fan Coil Units (FCU)
4. CHW Hydronic Pumping System
5. HW Hydronic Pumping System
6. Converters
7. Steam Systems
8. Supply, Return, Relief, Exhaust Air systems

C. Building Automation Systems (BAS)
   1. The entire BAS shall be subject to commissioning, including all hardware components, software, networking, programming and engineering services, and controls documentation.

1.4 RELATED WORK AND DOCUMENTS

A. The Cx process references many related Sections, particularly Section 01 91 00 - General Commissioning. It is important for all Contractors subject to the Cx process to be familiar with Section 01 91 00.

B. Refer to Section 01 91 00 for a complete list of Sections on Related Work.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 01 91 00 for a complete list of Definitions and Abbreviations.

1.6 REFERENCE STANDARDS

A. Refer to Section 01 91 00 for a complete list of Reference Standards.

1.7 DOCUMENTATION

A. Documentation shall be as required in Section 01 91 00. In addition, Contractor shall also provide to the CxA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:
   1. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to the Acceptance Phase. Factory Test Reports should be provided in PDF electronic format. These may include but are not limited to:
      a. Air Handling Units
      b. Variable Frequency Drives
      c. Fans Capacity
      d. Fan Sound Power Levels
      e. Pump Capacity
   2. Field Testing Agency Reports (other than TAB): Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports should be provided in PDF electronic format. These may include but are not limited to:
      a. Pipe Pressure Testing
      b. Duct Leakage Testing
      c. Vibration Testing
      d. Water Treatment
   3. TAB Plan: The Testing, Adjusting, and Balancing Plan shall include the following:
      a. Certifications on all instruments to be used throughout the testing. Certification must be documented within the previous 6 months.
      b. Résumés and Certification of individuals who will be balancing the systems.
      c. Detailed step-by-step plans for each procedure to be performed by the TAB Contractor.
d. Sample forms to be used for each measurement.
e. Sample balancing report.

4. Piping Cleaning, Flush, and Fill Plan: Contractor shall provide this document in accordance with details in this Section. CxA will review.

5. Temporary Operating and Conditioning Plan: Contractor shall provide in accordance with details in this Section. CxA will review.

6. Completed TAB Reports. CxA will review prior to FPT.

1.8 SEQUENCING AND SCHEDULING

A. Refer to Section 01 91 00.

1.9 COORDINATION MANAGEMENT PROTOCOLS

A. Coordination responsibilities and management protocols relative to Cx are initially defined in Section 01 91 00 and the Cx Plan, but shall be refined and documented in the Construction Phase Cx Kick-Off Meeting. Contractor shall have input into the protocols to be used and all Parties will commit to scheduling obligations. The CxA will record and distribute.

1.10 CONTRACTOR RESPONSIBILITIES

A. Refer to Section 01 91 00: Detailed Contractor responsibilities common to all Divisions are specified in Section 01 91 00. The following are additional responsibilities or notable responsibilities specific to Division 23.

B. Construction Phase
1. Provide skilled technicians qualified to perform the work required.
2. Provide factory-trained and authorized technicians where required by the Contract Documents.
3. Prepare and submit required draft Start-Up Documentation and submit along with the manufacturer’s application, installation and start-up information.
4. Provide assistance to the CxA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review FPT procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.
5. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this Section.
6. Start-Up, test/adjust/balance, and Turn-Over systems and equipment prior to functional performance testing by the CxA. Approved Start-Up Documentation shall be in accordance with Contract Documents, reference or industry standards, and specifically elsewhere in Part I of this Section.
7. Record Start-Up on approved Start-Up Documentation forms and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above and in Section 01 09 00. Each task or item shall be indicated with the Party actually performing the task or procedure.
8. TAB: As outlined in Section 23 05 93. Specifically as it relates to Cx:
   a. Attend Construction Phase Cx Kick-Off Meeting and Cx progress meetings beginning within 3 months of start of TAB work;
   b. Submit TAB Plan as indicated above;
   c. Meet with Cx team to review TAB procedures and documentation required;
   d. Demonstrate TAB procedures for repetitive tasks (zone balancing, AHU adjusting) as called for by the CxA;
   e. Participate in Action List dialogue;
   f. Provide all documentation electronically.
C. Acceptance Phase
1. Assist CxA in Functional Performance Testing. Assistance will typically include the following:
   a. Manipulate systems and equipment to facilitate Functional Performance Testing (as specified in Section 01 91 00 and Section 01 91 10);
   b. Provide any specialized instrumentation necessary for Functional Performance Testing;
   c. Manipulate BAS and other control systems to facilitate Functional Performance Testing (as specified in Section 01 91 00 and Section 01 91 10);
   d. Provide a TAB technician to work at the direction of CxA for up to 8 hours beyond assistance specified above.
   e. Provide a BAS technician to work at the direction of CxA for up to 16 hours beyond assistance specified above.

D. Warranty Phase
1. Maintain record documentation of any configurations, setpoints, parameters, etc. that change throughout the Warranty Period.
2. Provide representative for off-season testing as required by CxA.
3. Respond to warranty issues as required by Division 01 and the General Conditions.

1.11 EQUIPMENT SUPPLIER RESPONSIBILITIES
A. Refer to Section 01 91 00.

1.12 CONTRACTOR NOTIFICATION AND SCHEDULING
A. Refer to Section 01 91 00.

1.13 START-UP DOCUMENTATION
A. Refer to Section 01 91 00.

1.14 EQUIPMENT NAMEPLATE DATA
A. Refer to Section 01 91 00.

1.15 PIPING CLEANING, FLUSH, AND FILL PLAN
A. Contractors shall provide a “Piping Cleaning, Flush, and Fill Plan” to the CxA that provides a descriptive narrative and supporting calculations of the means and methods that will be used to clean out, flush, and fill the piping systems. CxA will review and post the final approved document to the Portal.

B. The “Piping Cleaning, Flush, and Fill Plan” shall incorporate and be inclusive of all requirements of individual Sections relating to piping and pipe cleaning and flushing. In addition to the requirements of any other related Section, this document shall consist of the following at a minimum for each individual hydronic loop:
   1. Overview schematic diagram of each of the hydronic systems, showing individual flow components such as chillers, boilers, pumps, heat exchangers, cooling towers, control valves, and strainers.
   2. Narrative and illustration indicating the equipment that will either participate or be bypassed by fluid flow during the clean and flush process.
   3. For equipment to be bypassed, description of the means for providing the bypass, including the type, size, and length of hoses or piping to be used.
4. Description of how flow is to be induced (permanent pumps, temporary pumps, etc.) and flow rates to be imposed during the flush process.
5. Calculation of resultant flow velocities in various portions of the piping system, with specific identification of the minimum velocity sections of the piping loop. Velocities should generally be shown to be above a 7 feet-per-second minimum speed to provide for adequate capability to flush and carry debris through the system to the appropriate strainer or clean-out location.
6. Description of cleaning methods and materials to be used to flush the system. Description shall include cleaning material and concentration, details of the cleaning process including duration of circulation and flushing intervals, criteria for determining a “clean” flush, and name and qualifications of cleaning or chemical treatment subcontractors to be used.
7. Identification and discussion of any isolated sections or ‘dead-legs’ that will be present, including means to provide cleaning and flushing for these sections.
8. Details of the strainers to be used for the flush and clean process, as well as final strainers to be used after cleaning. Contractor shall clean all strainers prior to turning over the system for commissioning.
9. If the cleaning and flushing process is to be phased in sections, details should be provided to clarify how clean sections will be protected as other sections are flushed.

1.16 TEMPORARY OPERATION AND CONDITIONING PLAN

A. Contractor shall be allowed to use permanent building equipment to provide temporary conditioning ONLY upon the approval of the A/E, Owner, and the CxA. Approval for such will only be given upon acceptance of a detailed Temporary Operating and Conditioning Plan provided by the individually involved subcontractors and compiled by the CM. This Temporary Operating and Conditioning Plan shall be a required element of the Construction IAQ Management Plan required for the LEED Credit EQ 3.1. The Temporary Operating and Conditioning Plan shall consider/address the following at a minimum:
1. Indicate that the full Start-Up protocol, including development and documentation of Start-Up Documentation as required by the specification will be performed for the temporary start-up. The Temporary Conditioning Plan shall include the Start-Up Documentation to be used, which shall be the same as those that will be used for final Start-Up.
2. Contractor shall address how equipment will be maintained in good, clean condition. Specifically address:
   a. Temporary Filtering of Air: Air filters used for construction shall be as or more effective than those specified for permanent use. Contractor shall remove construction filters and replace with new filters prior to FPT. Filters shall be maintained and replaced at the specified final pressure drop. Contractor shall install a manegelic gauge for visual indication of pressure drop as well as setting and adjusting the loaded filter DP switch for monitoring on the BAS.
   b. Temporary Filtering of Water and Condensate: Construction strainers shall be used while circulating fluid during construction. Construction strainer shall be finer than that specified for final strainers.
   c. Sealing/Filtering of Open Ducts: Address that all open ducts shall be either sealed or protected with filter media. Return or exhaust systems shall not be used during construction unless otherwise approved.
   d. Lubrication and Maintenance: Contractor shall maintain the systems and equipment in accordance with the manufacturer’s instructions. Contractor shall coordinate lubricants used with Owner’s operators. Frequency of lubrication and inspection shall be as recommended by manufacturer’s literature. Applicable maintenance lubrication schedules shall be included in the Plan. Draft maintenance logs shall be submitted with Plan and completed as maintenance is performed.
e. Operation Outside of Normal Ranges: Systems and equipment shall not be operated outside the range of specified conditions. The Temporary Conditioning Plan shall address how the Contractor will ensure that operation will not harm the equipment.

f. Emergency Condition Identification and Response Protocols: The Temporary Conditioning Plan shall address protocols for responding to equipment malfunctions and or harmful operation. Automatic safety and remote enunciation shall be in place to protect people and property. Temporary operation shall not be allowed until there is an automatic communication/enunciation medium such as a phone connection or an Internet connection. At a minimum, an alarm on the equipment used for temporary service shall be automatically sent to the Contractor’s 24 hour monitoring service and to the Owners help desk. The Contractor shall respond to and be responsible for securing conditions within the building. Owner shall assess the situation and as necessary secure utilities feeding the building from isolation points outside of the building.

3. Campus Utility Impact: The Temporary Conditioning Plan shall address the expected impact on the campus utilities involved in the temporary conditioning equipment. Specifically address:
   a. How the systems will be controlled to both ensure they are operating in range, and to avoid energy waste or inefficient conditions;
   b. Project the range of loads and flows to be imposed on the campus systems. For cooling, indicate how you will ensure a temperature split of at least 12°F;
   c. For campus chilled water connections, the bridge connection and automatic control of the bridge-related sequences shall be installed, functional and tested.

4. Building Protection: Address how the system will be controlled to avoid humidity conditions that could either promote mold growth or cause corrosion.

5. Equipment Reconditioning: Address with specific means and methods how the equipment used for temporary conditioning will be reconditioned to like-new condition. Belts, seals, bearings, couplings, or other parts that wear more than 3% of their expected life shall be replaced.

6. Cleaning: Address how ducts, pipes, coils, converters, air handling equipment, terminal units, etc. shall be cleaned prior to Turn-Over.

7. Operations Log: Contractor responsible for operating the equipment shall maintain a log of all activities associated with operating and maintaining equipment. Log shall be submitted to Owner on a frequency specified by the Owner.

8. Operating System Alterations: The Temporary Conditioning Plan shall address specific protocol for doing work on the systems.

9. Damages: Any material, device, component, or equipment that is assessed as damaged or as having a substantially shortened life as a result of temporary conditioning operation shall be replaced by the Contractor at no cost to the Owner or to the project.

10. Segregation: Where only portions of a system are to be used, Contractor shall specifically indicate how the used portion will be isolated from the unused portion. The Temporary Conditioning Plan shall address how to ensure that the reduced operation condition will be maintained within acceptable ranges, and/or how capacity will be throttled to keep all operating parameters in recommended ranges.

1.17 TRAINING EVENTS AND TRAINING PLAN

A. Contractors, subcontractor, vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 01 91 00 and the individual Specifications.

1.18 SYSTEMS MANUAL AND O&M DOCUMENTATION CONTENT - PREPARATION AND LOGISTICS

A. Refer to Section 01 91 00 the individual Specifications.
1.19 BAS TRENDING REQUIREMENTS
A. Trending requirements are as specified in Section 01 91 00 and Section 23 08 01
B. The BAS Contractor shall configure and analyze all trends required under Section 23 02 01.

1.20 FUNCTIONAL PERFORMANCE TESTING
A. Contractor shall participate in the initial samples of Functional Performance Testing as stipulated in Section 01 91 00 and Section 01 91 10.

1.21 FPT ACCEPTANCE CRITERIA
A. Acceptance criteria for tests are indicated in Section 01 91 10 and in the specification Sections applicable to the systems being tested. Unless indicated otherwise, the criteria for acceptance will typically be that specified with the individual system, equipment, component, or device.

PART 2 - PRODUCTS
2.1 INSTRUMENTATION
A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:

B. Temperature sensors and digital thermometers shall have a certified calibration within the past year and a resolution of +/- 0.1°F.

C. Pressure sensors shall have an accuracy of +/- 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

D. All equipment shall be calibrated according to the manufacturer’s recommended intervals. Calibration tags shall be affixed or certificates readily available.

E. Standard Testing Instrumentation: Standard instrumentation used for testing air and water flows, temperatures, humidity, noise levels, amperage, voltage, and pressure differential in air and water systems related to functional testing shall be provided by CxA.

F. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and turned over to the Owner upon project completion.

2.2 WEB-BASED COMMISSIONING PORTAL
A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal (‘Portal’) to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CxA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.
B. Refer to Section 01 91 00 the individual Specifications for additional information and requirements for using the Portal.

2.3 TEST KITS FOR METERS AND GAUGES

A. Test kits for meters and gauges shall be provided to the Owner new and in good condition. Previously used kits will be unacceptable. Kits shall be submitted prior to the Acceptance Phase. Kits included shall be as a minimum:
   1. Digital indication of temperature and pressure with associated sensors to work with the P/T test ports
   2. Companion readout kit (with fittings) for calibrated balancing valve with ranges as required by all devices on this project

PART 3 - EXECUTION

3.1 GENERIC START-UP DOCUMENTATION - GENERAL

A. Part III of this Section outlines ‘generic’ or minimally acceptable Start-Up Documentation (which are defined to include both ‘Start-Up Checks’ and ‘Start-Up Tests’) and individual systems training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimally acceptable guideline for required Contractor development of Start-Up Documentation. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized final Start-Up Documentation specific to the equipment and systems installed on this project.

B. Section 01 91 00 defines the systems and equipment Start-Up process in detail and provides definitions for Start-Up Documentation, including the generic Start-Up Documentation provided below.

3.2 START-UP DOCUMENTATION COMMON TO ALL SYSTEMS

A. The following Start-Up Documentation (Checklists and Tests) shall be considered common to all systems:
   1. Checkout shall proceed from lower level devices to larger components to the entire system operation.
   2. Verify labeling is affixed per specification and visible.
   3. Verify prerequisite procedures are done.
   4. Inspect for damage and ensure none is present.
   5. Verify system is installed per the manufacturer’s recommendations.
   6. Verify system has undergone Start-Up per the manufacturer’s recommendations.
   7. Verify that access is provided for inspection, operation and repair.
   8. Verify that access is provided for eventual replacement of the equipment.
   9. Verify that record drawings, submittal data and O&M documentation accurately reflect the installed systems.
  10. Verify all gauges and test ports are provided as required by contract documents and manufacturer’s recommendations.
  11. Verify all recorded nameplate data is accurate.
  12. Verify that the installation ensures safe operation and maintenance.
  13. Verify specified replacement material/attic stock has been provided as required by the Contract Documents.
  14. Verify all rotating and moving parts are properly lubricated.
  15. Verify all monitoring and ensure all alarms are active and set per Owner’s requirements.
  16. Complete all nameplate data and confirm that ratings conform to the design documents.
3.3 VALVES

A. Include all applicable “Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:
   1. Operate all valves, manual and automatic, through their full stroke. Ensure smooth operation through full stroke and appropriate sealing or shutoff.
   2. Verify actuators are properly installed with adequate clearance.
   3. Verify all valves are labeled per the construction documents. Confirm that concealed valves are indicated on the finished building surface.
   4. For automatic pneumatically-operated valves, verify spring range and adjust pilot positioners where applicable.
   5. For electronically operated valves, check the stroke and range.
   6. For all automated valves controlled by a program, ensure that the minimum and maximum stroke and ranges on the valves are coordinated with the limits entered in the program.

3.4 METERS AND GAUGES

A. Include all applicable “Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:
   1. Adjust faces of meters and gauges to proper angle for best visibility.
   2. Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.
   3. For meters and gauges requiring temporary manual connection of read-out device such as pressure taps on a flow measuring device, ensure threads are clean and that connection can be made easily.
   4. Meters and gauges requiring manual connection of readout device shall be installed with adequate access to allow connection of device with normal tools.

3.5 MECHANICAL IDENTIFICATION

A. Start-Up Checks: Perform the following checks:
   1. Verify all valve tags, piping, duct, and equipment labeling corresponds with drawings and indexes and meets requirements specified. Correct any deficiencies for all piping and duct systems.
   2. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
   3. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.6 MECHANICAL INSULATION

A. Include all applicable “Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Examine all piping, systems and equipment specified to be insulated.
   1. Ensure quality of insulation. Patch and repair all insulation damaged after installation.
   2. Ensure the integrity of vapor barrier around all cold surfaces.
3.7 PIPING - GENERAL

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: These procedures apply to all installed piping systems, including underground site utilities.
   1. Inspect all piping for proper installation, adequate support (with appropriate vibration isolation where applicable) and adequate isolation valves for required service.
   2. Submit welding certifications as required by the applicable specification section or referenced ASME specification.
   3. Submit certified welding inspection results per the applicable specification section or referenced ASME specification. ASME B31.1 requires 100% inspection based on pressure class.
   4. Provide notification of pipe cleaning and flushing activities.
   5. Flush and clean all piping and clean all strainers. Provide documentation of all related procedures.
   6. Ensure adequate drainage is provided at low points and venting is provided at high points.
   7. Ensure facilities to effectively drain and fill the system are in place.
   8. Ensure air is thoroughly removed from the system as applicable.
   9. Ensure all piping is adequately supported and anchored to allow expansion. Bump across-the-line pumps and inspect for excessive pipe movement.
   10. Provide notification of pressure testing.
   11. Pressure and/or leak test all applicable systems in accordance with the requirements in the applicable sections, ASME B 31.1 and 39.1 as applicable.
   12. Sterilize applicable piping systems as specified in the individual Sections and as required by regulatory authorities.
   13. Submit pressure test reports that document the pressure testing results with certification of the results.
   14. Verify the operation of applicable safety relief valves, operating controls, safety controls, etc. to ensure a safe installation.
   15. Set and adjust fill, pressure, or level controls to the required setting.

3.8 AC MOTORS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:
   1. Verify proper alignment, installation, and rotation.
   2. Verify properly sized overloads are in place.

C. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up and as specified in manufacturer's instructions:
   1. Measure insulation resistance, phase balance, and resistance to ground.
   2. Measure voltage available to all phases. Measure amps and RPM after motor has been placed in operation and is under load.
   3. Record all motor nameplate data.

3.9 BEARINGS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.
B. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions. This applies to all bearings on fans, pumps, compressors, and other equipment installed under this Division.
   1. Check alignment as applicable.
   2. Lubricate all bearings per the manufacturer's instructions. When bearing is used for temporary conditioning, lubricate on manufacturer's recommended frequency and document it.

C. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up and as specified in manufacturer's instructions:
   1. Use infrared thermometer to measure temperature at peak conditions. Ensure temperature is below manufacturer's recommendations.
   2. For bearings in drives with motors over 10 HP, use a vibration meter and measure the maximum peak-to-peak acceleration. Compare it to the Vibration Severity Chart. Rectify any condition causing severity indicated as "Rough" or worse.

3.10 VARIABLE SPEED DRIVES

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: Provide the services of a factory authorized service representative to test and inspect unit installation, provide start-up service, and to demonstrate and train Owner's maintenance personnel as specified below.

C. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:
   1. Check unit for shipping damage.
   2. Perform a point-to-point continuity test for all field installed wiring interconnections. Verify terminations of field-installed wiring.
   3. Check for proper torque on connections.
   4. Verify use of shielded cable where specified and check that shields have been terminated properly.
   5. Verify grounding.
   6. Check motor nameplate against drive input rating.
   7. Manually rotate motor shaft to ensure free rotation.
   8. Check that motor leads are not grounded.

D. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up and as specified in manufacturer's instructions. Ensure device and system which drive is serving is configured to withstand the device operation specified below.
   1. Adjust the 'Minimum Voltage Adjustment' to enable starting but not to draw excessive power at start.
   2. Adjust the 'Volts/Hz Adjustment' to proper setting.
   3. Adjust the 'Acceleration and Deceleration Rates' to the specified times.
   4. Adjust 'Current Limiting' to coordinate with the overcorrect device and protect the motor.
   5. Set the 'Maximum and Minimum Speed' pots.
   6. Manually ramp fan speed from minimum to maximum and check for excessive noise and vibration.
   7. Determine any critical speeds to avoid and set these in the drive.
   8. Check for acceptable voltage and current distortion on the power system. Record the input and output voltages and currents showing the harmonic content as a percentage of the base frequency.
   9. Measure and record overall efficiency at 50%, 75%, and 100%.
   10. Record the motor terminal voltage.
E. **Training:** Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance. Review data in manufacturer's Operation and Maintenance Manuals.

### 3.11 HYDRONIC PIPING

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. **Start-Up Checks:** Perform the following checks during start-up:
   1. Prepare hydronic and test piping in accordance with applicable Section and ASME B 31.9 and/or B 31.1.
   2. Flush system with clean water in accordance with applicable Section.
   3. Clean strainers.
   4. Check expansion tanks to determine that they are not air-bound and that the system is completely full of water.
   5. Set automatic fill valves for required system pressure.
   6. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
   7. Set and coordinate automatic fill pressure and relief valve settings.

C. **Start-Up Tests:** Perform the following tests, measurements, or procedures during start-up:
   1. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

### 3.12 STEAM AND CONDENSATE PIPING

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. **Start-Up Checks:** Perform the following checks during start-up:
   1. Prepare and test steam and condensate piping in accordance with applicable Section and ASME B31.9 and or B31.1 as applicable.
   2. Flush the system with clean water.
   3. Remove, clean, and replace strainer screens.
   4. Gradually warm-up piping and connected equipment. Introduce steam to piping system by throttling valves.
   5. Take precautions to prevent water hammer or slugging in piping.
   6. Vent air and non-condensable gases from system.
   7. Supervise condensate removal at system traps. Temporarily, bypass traps if required.
   8. Verify complete condensate removal from piping and equipment and that traps are functioning properly.

### 3.13 REFRIGERANT PIPING

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. **Start-Up Checks:** Perform the following checks during start-up:
   1. Examine rough-in for refrigerant piping systems to verify actual locations of piping connections prior to installation.
   2. Inspect, test, and perform corrective action of refrigerant piping in accordance with ASME Code B31.5, Chapter VI.
3. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

4. Clean and inspect refrigerant piping systems in accordance with the applicable section.

5. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

C. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing, and preventative maintenance of refrigerant piping valves and refrigerant piping specialties.

3.14 PUMPS

A. Include all applicable "Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. Refer to ‘AC Motors’ in this Section.

C. Refer to ‘Bearings’ in this Section.

D. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

E. Start-Up Checks: Perform the following checks during start-up:
   1. Check suction lines connections for tightness to avoid drawing air into the pump.
   2. Clean and lubricate all bearings.
   3. Check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
   4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.
   5. Clean associated strainers.
   6. Check that the proper overloads have been installed in the starter and are the correct size.
   7. Verify that the integrity of the vibration isolation is maintained throughout the support and the connections.
   8. Align pump within manufacturers recommended tolerances.
   9. Ensure all associated piping has been cleaned, tested, and deaerated.
   10. Verify that all thermometers and gauges are installed, are clean and undamaged, and are functional.

F. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up:
   1. Start the pump per the manufacturer’s instructions.
   2. Check the general mechanical operation of the pump and motor.
   3. Verify that checkvalve seal is appropriate.
   4. Check noise and vibration levels and ensure they are within the manufacturer’s recommended tolerances.
   5. Check that the NPSH is with that allowable for the operating condition.
   6. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.15 STEAM-TO-HOT WATER CONVERTERS

A. Include all applicable "Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.
B. Refer to Division 23 Section "Testing, Adjusting, and Balancing".

C. Start-Up Checks: Perform the following checks during start-up:
   1. Ensure converters are cleaned and flushed upon completion of installation in accordance with manufacturer's start-up instructions.

D. Start-Up Tests: Perform the following tests during start-up:
   1. Hydrostatically test assembled converter and piping in accordance with applicable sections of ASME Boiler and Pressure Vessel Code.
   2. Start-up converters in accordance with manufacturer's start-up instructions.
   3. Test controls and demonstrate compliance with requirements.
   4. Replace damaged or malfunctioning controls and equipment.
   5. Record all parameters (flow, temperatures, pressures, etc.) and tests and submit report.

3.16 STEAM CONDENSATE PUMPS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: Start-up condensate pumping equipment in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements.
   1. Refer to AC Motors.
   2. Refer to Pumps.

3.17 TERMINAL UNITS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following inspections/checks during start-up:
   1. After construction is completed, including painting if applicable, clean unit exposed surfaces.
   2. Vacuum-clean terminal coils and inside of cabinets.
   3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
   4. Verify adequate access for maintenance.
   5. Check power and control voltages.
   6. Check rotation of fan where applicable.
   7. Check calibration and operation of the controlling elements.
   8. Check control valves for required close-off and fail position.
   9. Install new filter units for terminals requiring same.

3.18 VAV TERMINAL UNITS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Refer to and coordinate with Division 23 Section "Testing, Adjusting, and Balancing".

C. Start-Up Checks: Perform the following inspections/checks during start-up:
   1. After construction is completed, including painting if applicable, clean exposed unit surfaces.
   2. Clean factory-finished surfaces. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
3. Ensure unit is properly supported and that integrity of vibration isolation has been maintained where applicable.
4. Ensure that air velocity sensor is correctly installed and that inlet/outlet restrictions for accurate measurements have been met.
5. Ensure air inlet is free of obstructions. Start fans and ensure proper rotation (as applicable). Measure and record motor amperage and voltage.
6. Ensure the coils are undamaged, combed, and vented.
7. Check the heating device and control to ensure functionality and proper installation. Check stroke and range on the valve and ensure it closes and seals tightly.

D. Start-Up Tests: Perform the following during start-up:
1. Calibrate and adjust the airflow control parameters. Set applicable min and max setpoints. Coordinate with the ATC contractor as necessary to obtain flow parameters required.
2. Install new filters where required.
3. Set all temperature and humidity setpoints to those as directed by Owner.
4. Record supply air temperature at full cooling and at full heating (compare both with current air handler temp)

3.19 CENTRAL-STATION AIR HANDLING UNITS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide startup service, and to demonstrate and train Owner's maintenance personnel as specified below.

C. References: The following additional Sections shall also apply:
1. Refer to AC Motors in this Section.
2. Refer to Fans in this Section.
3. Refer to Bearings in this Section.
4. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.
5. Refer to Division 23 Section “BAS Commissioning” for procedures for starting the controls related to the AHU.

D. Start-Up Checks: Perform the following inspections/checks during start-up:
1. Inspect the field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
2. Cleaning: Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face. Ensure volatile irritants are contained and kept out of occupied spaces.
3. Adjust and lubricate dampers and linkages for proper damper operation.
4. For field fabricated units, ensure the sections are properly connected within acceptable tolerances.
5. Seal all penetrations to be air-tight and ensure access doors seat tightly.
6. Verify that unit is secure on mountings and supporting devices and connections for piping, ductwork, and electrical are complete.
7. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
8. Ensure vibration isolation integrity is maintained throughout the AHU installation and its connections.
9. Tension all belts per the drive manufacturer’s recommendations.
10. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
11. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.


13. Install clean filters.

14. Ensure condensate drains properly and that trap is adequate.

15. Stroke all valves and damper to ensure free and full travel.

E. Start-Up Tests: Perform the following during start-up:
1. Pressure test units as required in the AHU specification

F. Training: Contractor shall train Owner's maintenance personnel including:
1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of manufacturer's Operating and Maintenance Manuals.

3.20 FANS

A. Include all applicable "Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. References: The following additional Sections shall also apply:
1. Refer to AC Motors in this Section.
2. Refer to Bearings in this Section
3. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.
4. Refer to Division 23 Section "BAS Commissioning" for procedures for starting the controls related to the AHU.

C. Start-Up Checks: Perform the following inspections/checks during start-up:
1. Inspect the field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
2. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face. Ensure volatile irritants are contained and kept out of occupied spaces.
3. Adjust and lubricate dampers and linkages for proper damper operation.
4. Verify that unit is secure on mountings and supporting devices and connections for ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
5. Ensure vibration isolation integrity is maintained with the fan installation and associated connections.
6. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
7. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
8. Stroke all dampers to ensure free and full travel.

D. Training: Contractor shall train Owner's maintenance personnel including:
1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of manufacturer's Operating and Maintenance Manuals.
3.21 AIR CLEANING AND FILTERS

A. Include all applicable “Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: Operate installed air filters to demonstrate compliance with requirements. Test for air leakage of unfiltered air while system is operating. Correct malfunctioning units at site, then retest to demonstrate compliance; otherwise remove and replace with new units, and proceed with re-testing.

3.22 METAL DUCTWORK

A. Include all applicable “Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure using polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

C. Start-Up Checks: Perform the following checks during start-up and as specified:
   1. Clean ductwork internally of dust and debris, unit-by-unit as it is installed. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
   2. Strip protective paper from stainless ductwork surfaces if applicable, and repair finish wherever it has been damaged.

D. Start-Up Tests: In addition to specifications, perform the following as a minimum:
   1. Leakage Tests: After each duct system which is constructed for duct classes over 3" is completed, test for duct leakage in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Repair leaks and repeat tests until total leakage is less than 1% of system design air flow.
   2. Balancing: Refer to Division-23 section "Testing, Adjusting, and Balancing" for air distribution balancing of metal ductwork; not work of this section. Seal any leaks in ductwork that become apparent in balancing process.

3.23 DUCTWORK ACCESSORIES

A. Include all applicable “Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified:
   1. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

C. Start-Up Tests: In addition to specifications, perform the following as a minimum:
   1. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak proof performance.
   2. Label access doors in accordance with Division 23 Section "Mechanical Identification".
   3. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.
   4. Final positioning of manual dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing".
5. Fire Damper Testing: For every fire damper, remove the fusible link and verify that the damper operates freely and closes tightly. Reinstall the fusible link.

3.24 AIR TERMINALS

A. Include all applicable “Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Upon completion of installation and prior to initial operation, check that air terminals are:
   1. Properly installed with the proper airflow direction.
   2. Properly supported with vibration isolation integrity maintained where applicable.
   3. Duct connections to air terminals are leak-tight.
   4. Operable dampers travel free.
   5. Airflow measuring devices are properly installed and connected.
   6. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.
   7. Clean exposed factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.25 BUILDING AUTOMATION AND CONTROL SYSTEMS

A. Include all applicable “Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Start-Up Checks: Perform the following checks during start-up and as specified:
   1. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

C. Start-Up Tests: Refer to Section 230801 “BAS Commissioning”. This requires manufacturers authorized representative to start-up, test, adjust, and calibrate direct digital and other microprocessor-based control systems and demonstrate compliance with requirements. This will include verification of sequences, normal and emergency operations, calibration, interfaces, and interlocks, etc.

3.26 TESTING, ADJUSTING, AND BALANCING

A. Reference: Perform testing, adjusting, and balancing (TAB) procedures on each system identified, in accordance with the detailed procedures outlined in the respective section and the referenced standards.

B. Start-Up Checks: In addition to specifications, perform the following as a minimum:
   1. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
   2. Patch insulation, ductwork, and housings, using materials identical to those removed.
   3. Seal ducts and piping, and test for and repair leaks.
   4. Seal insulation to re-establish integrity of the vapor barrier.
   5. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
   6. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.
   7. Test and adjust mechanical systems for sound and vibration in accordance with the detailed instructions of the referenced standards.
C. Training:
1. Train the Owner's maintenance personnel on troubleshooting procedures and on testing, adjusting, and balancing procedures.
2. Review for the Owner’s personnel the locations of TAB reports and data.

3.27 ROOM/ZONE CHECKOUT

A. Include all applicable ‘Start-Up Checks Common to All Systems’. Additional Start-Up Checks and Tests are as follows.

B. Contractor shall complete a checklist acknowledging completion of Div. 23 responsibilities for all rooms. Checklist shall include items such as the following as applicable:

C. Typical Room:
1. Diffusers, registers, and grilles installed and cleaned.
2. Zone controls in place and functional.
3. All terminal equipment functional, clean, and punched out.
4. Occupancy schedules entered with applicable control setpoints.

3.28 SEQUENCING ILLUSTRATION

A. Reference Section 01 91 00.

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SECTION 23 08 01 – BUILDING AUTOMATION SYSTEM (BAS) COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. BAS Start-Up and Functional Performance Testing.

B. Validation of proper and thorough installation of BAS and associated equipment.

C. Generic Start-Up Documentation for BAS.

D. Development of final Start-Up Documentation for BAS.

E. Functional Performance Testing of BAS.

F. Coordination of BAS-related training.

G. Documentation of BAS Operation and Maintenance Documentation.

1.2 GENERAL DESCRIPTION

A. This section defines responsibilities of the Building Automation System Contractor to commission the BAS.

B. Commissioning (Cx) is the process of ensuring that (i) all building systems are installed and perform interactively according to the design intent; (ii) systems are efficient and cost effective and meet the Owner’s operational needs; (iii) that the installation is accurately documented; and (iv) that the Operators are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems, and establishes testing and communication protocols to advance the building systems from installation to optimized, fully-dynamic operation.

C. Commissioning Authority (CxA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.

D. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.

1.3 SCOPE

A. The scope of Commissioning on this project shall include the entire BAS system.

1.4 RELATED WORK AND DOCUMENTS

A. The Cx process references many related Sections, particularly Section 01 91 00 - General Commissioning. It is important for all Contractors subject to the Cx process to be familiar with Section 01 91 00.

B. Refer to Section 01 91 00 for a complete list of Sections on Related Work.
C. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 01 91 00 for a complete list of Definitions and Abbreviations.

B. POT (Portable Operators Terminal): Portable operator workstation (typically a laptop computer) that has BAS software loaded and the capability to access, program, and edit the BAS.

C. HHD (Hand-Held Device): Portable device (typically with limited functionality) that is used to access components of the BAS. May be a standard PDA or proprietary device/interface.

1.6 REFERENCE STANDARDS

A. Refer to Section 01 91 00 for a complete list of Reference Standards.

1.7 CONTRACTOR RESPONSIBILITIES

A. General responsibilities of the BAS Contractor (BAC) are specified in Section 01 91 00. The following indicate additional specific responsibilities of the BAS Contractor.

B. Assist CxA in verification and Functional Performance Testing. Assistance will typically include the following:
   1. Establish trend logs of system operation as specified herein.
   2. Manipulate systems and equipment to facilitate Functional Performance Testing as outlined in Section 01 91 10 and Section 01 91 11. Typically, this will only be for initial samples of like systems.
   3. Provide POTs or operator workstations in locations convenient to testing activities as specified below.
   4. Provide CxA with appropriate passwords, keys, and access to control panels and workstations.
   5. Where control systems do not allow a test mode or the overriding of physical input values for testing, program an interim virtual point for all inputs that can be used to represent the point and be overridden for testing.

C. Provide a control technician to work at the direction of the CxA for software optimization assistance for a minimum of 16 hours during the Acceptance Phase of the project.

D. Controls Parameter Matrix: Contractor shall provide a form summarizing all setpoints and alarm parameters and alarming strategies for the Owner to complete. Organize a meeting to discuss the desired initial setpoints and alarm parameters. Contractor shall enter the requested setpoints and alarm parameters at completion of start-up and record the applicable settings in the Start-Up Documentation.

E. Final Systems Operation Training: The BAC shall train the Owner and Operators on whole-building operation and use of the BAS. This training shall focus primarily on BAS control of building systems and operation and its impact on building performance, and shall be conducted after Functional Completion. Additional information is provided in Section 01 91 00.

F. Compensate the Owner for any BAS Contractor site time incurred due to incompleteness of systems or equipment at time of Functional Performance Testing. All testing failures which require on-site time for retesting will be considered actual damages to the Owner. The contract sum shall be reduced by contract modification at a rate of $145 per worker-hour of on-site time.
necessary to retest failures. All parties under contract with the Owner who are affected by the retesting shall be included in the contract modification. Refer to Section 01 91 00 and 01 91 10 for more details.

1.8 SEQUENCING

A. Refer to Section 01 91 00.

B. The following list outlines the general sequence of events for Commissioning of the BAS.

1. Construction Phase:
   a. Collaborate on construction scheduling.
   b. Submit Product data and Shop Drawings, and receive approval.
   c. Meet with Cx Team to coordinate with all trades.
   d. Begin BAS installation.
   e. Submit refinement of generic Start-Up Documents incorporating manufacture-specific start-up requirements accompanied by manufacturers pre-printed start-up forms for all equipment provided by the BAS Contractor.
   f. Receive BAS Start-Up Documents approval from CxA.
   g. Submit Training Plan content.
   h. Receive approval of Training Plan content.
   i. Provide alarm list and receive approval.
   j. Provide sample graphics and receive approval.
   k. Complete BAS installation.
   l. Place systems under BAS control.
   m. Enter alarms as approved by Owner.
   n. Complete BAS graphics.
   o. Perform BAS system start up and complete Start-Up Documentation.
   p. Submit completed BAS Start-Up Documentation.
   q. Prepare and initiate trend log data storage and format trend graphs.
   r. Train Owner on BAS operation and maintenance.
   s. Formal BAS System Turn-Over Meeting.
   t. Submit commissioning BAS Software/Access and provide checkout technician level (monitoring, point override/test, and setpoint adjustment) password access to Owner and CxA.
   u. Receive BAS Start-Up Documentation approval and approval to schedule BAS demonstration of completeness.
   v. Demonstrate systems to CxA and Owner.
   w. Submit trend logs in format specified.
   x. Receive FPT or BAS demonstration approval and approval to schedule Acceptance Phase.

2. Acceptance Phase
   a. Demonstrate the systems are available and ready for functional testing which enables start of Functional Performance Testing.
   b. CxA performs Functional Performance Testing and BAS Contractor participates as outlined in 01 91 10.
   c. Two-week BAS Observation Period to witness stable BAS operation.
   d. Receive Functional Completion approval for the BAS.

3. Substantial Completion.

4. Warranty Phase
   a. Provide administrator access password access to Owner.
   b. Train Owner on final sequences and modes of operation (Final Systems Operation Training).
   c. Update Systems Manual content with any changes.
   d. Revise and re-submit record drawings and O&M manuals.
   e. Install framed control drawings.
f. Final Completion.
g. Opposite-season operational test and Functional Performance Testing.
h. Receive opposite-season operational test and FPT approval.
i. Revise and re-submit record drawings and O&M manuals.
j. Update framed control drawings.
k. Complete owner training.
l. End of Warranty Period.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:

B. Temperature sensors and digital thermometers shall have a certified calibration within the past year and a resolution of +/- 0.1°F.

C. Pressure sensors shall have an accuracy of +/- 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

D. All equipment shall be calibrated according to the manufacturer’s recommended intervals. Calibration tags shall be affixed or certificates readily available.

E. Standard Testing Instrumentation: Standard instrumentation used for testing air and water flows, temperatures, humidity, noise levels, amperage, voltage, and pressure differential in air and water systems related to functional testing shall be provided by CxA.

F. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and turned over to the Owner upon project completion.

1.2 WEB-BASED COMMISSIONING PORTAL

A. General: The Cx Portal (‘Portal’) is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CxA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process. The Portal uses a hierarchical object tree to represent building systems, components and devices. From this object tree, one can access associated information at and below the applicable level. All applicable elements of information are associated with the object tree. The Portal facilitates either completing information directly via the software or by printing forms to fill out in the field.

B. Participation: All general and major subcontractors participating in the Cx process shall participate in the use of the Portal to document the Cx procedures.

C. Requirements for Use: Options for accessing and interfacing with the Cx Portal are as follows:
   1. Print, Test, and File: Using this approach, Contractors simply go online to the Portal using a web browser, print checklists and tests as needed, fill them out in the field, and enter the results back into the Portal database when completed.
2. **Online in the Field:** The applicable documents can be accessed and filled out live and online if the Contractor has the means to access the Internet while working in the field using a local Wi-Fi network or wireless air card.

3. **Database Client:** At the Contractor's option, the CxA can provide the Contractor with a software tool that will allow the Contractor to download electronic test database files from the Portal, work on the database files in the field electronically (but offline), and later synchronize their entries with the master database on the Portal.

D. **Portal Training:** Included in the contract are two Contractor training sessions given by the CxA (one scheduled near the Construction Phase Cx Kickoff Meeting and one scheduled prior to the first equipment Start-Up). Contractors shall send at least one representative to at least one training session. Each Contractor is entitled to two hours phone technical support beyond training sessions.

### 1.3 TAB & COMMISSIONING PORTABLE OPERATORS TERMINAL

A. **Provide the CxA with all software, connection devices, licenses, passwords, etc. to facilitate connection to the BAS throughout the building.** Provide a license to graphic software, and all operating software necessary for testing and configuration of all control elements at all levels. License may be a temporary license that will expire after the completion of the Warranty Period. Options include:
   1. A laptop computer provided by BAS Contractor for dedicated use by the CxA throughout the Construction and Acceptance Phases. This would be turned over to the Owner at the end of the Acceptance Phase.
   2. **Browser access to the full graphic software:** CxA will provide laptop, however BAS Contractor shall set up the laptop to successfully connect.
   3. Licensed client software to be installed on CxA computer: BAS Contractor shall install the software and ensure it is functional.
   4. **Terminal Services session access to a graphic server with required CALs to allow use of all required software.** BAS Contractor shall configure the CxA computer to connect to the terminal session.

B. **Access to the BAS must be provided throughout the building as more fully defined as follows:**
   1. Full wireless connection to the graphic server throughout the building will be adequate.
   2. Network connection for full access to the graphic server within 50' of any point in the building.
   3. Exception to 1 and 2 above: An acceptable alternative to full building access to the graphic server relating to terminal controls shall be providing to the CxA the devices and software required to connect to local terminal controllers through a connection port in the space such as connection to a jack on the temperature sensor (basically what is required by TAB specified below). This does not apply to mechanical rooms as full graphic access is required in mechanical rooms.

C. **Provide software required by TAB to calibrate all flow sensors.** TAB will provide computer to be used as a portable operator's terminal. Any manufacturer specific hardware such as connection cables, converters, hand held devices, etc. shall be provided by the BAS Contractor.

D. **Connections shall be provided local to the device being calibrated.** For instance, for VAV boxes, connection of the operator’s terminal shall be either at the sensor as well as at the box. Otherwise a wireless system shall be provided to facilitate this local functionality.
PART 2 - EXECUTION

2.1 BAS START-UP TESTING, ADJUSTING, CALIBRATION

A. BAS work and/or systems shall be fully functioning prior to Demonstration and Acceptance Phase. Contractor shall start, test, adjust, and calibrate all work and/or systems under this contract, as described below:

1. Inspect the installation of all devices. Review the manufacturer’s installation instructions and validate that the device is installed in accordance with them.
2. Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.
3. Verify integrity/safety of all electrical connections.
4. For the following control settings, initially use the control setting that was used by the existing BAS unless otherwise indicated. For AHUs that use a throttled outside air damper position when minimum outside air is required, Contractor shall mark existing minimum outside air damper position to allow replication by new BAS installation.
5. Coordinate with TAB Contractor to obtain and with CxA to fine tune control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB Contractor, and note any TAB deficiencies in the BAS Start-Up Documentation:
   a. Optimum duct static pressure setpoints for VAV air handling units.
   b. Minimum outside air damper settings for air handling units.
   c. Optimum differential pressure setpoints for variable speed pumping systems.
   d. Calibration parameters for flow control devices such as VAV boxes and flow measuring stations. BAS Contractor shall provide hand held device as a minimum to the TAB and CxA to facilitate calibration. Connection for any given device shall be local to the device (i.e., at the VAV box or at the thermostat). HHD or POT shall allow querying and editing of parameters required for proper calibration and Start-Up.
6. Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the BAS Start-Up Documentation.
7. Check and set zero and span adjustments for all transducers and transmitters.
8. For dampers and valves:
   a. Check for adequate installation including free travel throughout range and adequate seal.
   b. Where control loops are sequenced, check for proper control without overlap.
9. For actuators:
   a. Check to insure that device seals tightly when the appropriate signal is applied to the operator.
   b. Check for appropriate fail position, and that the stroke and range is as required and coordinated with the programmed ranges when it is operating under normal conditions.
   c. For pneumatic operators, adjust the operator spring compression as required to achieve close off. If positioner or volume booster is installed on the operator, calibrate per manufacturer’s procedure to achieve spring range indicated. Check split range positioners to verify proper operation. Record settings for each device.
   d. Check the stroke and range under actual loading conditions and validate that they correlate with programmed values.
   e. For sequenced electronic actuators, calibrate per manufacturer’s instructions to required ranges.
10. Check each digital control point by making a comparison between the control command at the CU and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the OI display. Record the results for each device.

11. For outputs to reset other manufacturers devices (such as VSDs) and feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.

12. Verify proper sequences by using the approved Start-Up Documentation to record results. Verify proper sequence and operation of all specified functions.

13. Verify that all safety devices trip at appropriate conditions. Adjust setpoints accordingly.

14. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the BAS Start-Up Documentation. Except from a start-up, maximum allowable variance from setpoint for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any step-change (for which the system has the capability to respond) in the control loop, the following tolerances shall be maintained (exceptions noted):
   a. Duct air temperature: ±1°F
   b. Zone temperature: ±3°F within 3 minutes and control within ±2°F
   c. Chilled water temperatures: ±1°F
   d. Hot water temperatures: ±2°F
   e. Duct air pressure: ±0.25” w.g.
   f. Water pressure: ±1 psid
   g. Duct relative humidity: ±3% when adding humidity
   h. Zone relative humidity: ±5% when adding humidity
   i. Terminal air flow control: ±5% of setpoint. This includes all VAV terminal control and exhausted BSCs, canopy hoods, ventilated cage racks, necropsy tables, and other scientific equipment with supply or exhaust ventilation.

15. For communication interfaces and BAS control panels:
   a. Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the record drawings.
   b. Ensure that terminations are safe, secure and labeled in accordance with the record drawings.
   c. Check power supplies for proper voltage ranges and loading.
   d. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
   e. Check for adequate signal strength and acceptable bandwidth utilization on communication networks.
   f. Check for stand-alone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at Operator Interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
   g. Ensure that all outputs and devices fail to their proper positions/states.
   h. Ensure that buffered and/or volatile information is retained through power outage.
   i. With all system and communications operating normally and all trends functioning, sample and record update/annunciation times for critical alarms fed from the panel to the Operator Interface.
   j. Check for adequate grounding of all BAS panels and devices.
   k. Run self diagnostic routines and ensure they are functional.
   l. Check the memory allocation and loading to ensure adequate and excess capacity is available and that it will not affect control functionality.

16. Coordinate desired initial alarm strategies with Owner’s Operators. Set all required alarms and document the initial settings in the Start-Up Documentation.

17. Coordinate all initial setpoints with Owner’s Operators. Ensure those setpoints are active.

18. For Operator Interfaces:
a. Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.
b. Output all specified BAS reports for review and approval.
c. Verify that the alarm printing and logging is functional and per requirements.
d. Verify that trend archiving to disk and provide a sample to the CxA for review.
e. Verify alarm enunciation functionality. Time delay from actual occurrence to the time updated or enunciated on the screen. Ensure it is per the specified requirements.
f. Verify that real time and historical trends are accessible and viewable in graph format.
g. Verify that paging/dial out alarm annunciation is functional.
h. Verify the functionality of remote OIs and that a robust connection can be established consistently.
i. Verify that required third party software applications required with the bid are installed and are functional.
j. Demonstrate open protocol and custom third party interfaces reliably communicate and check response time.
k. Verify response times and screen update and refresh times are per the requirements.
l. Verify that all custom programs are editable from the OI. Check upload, download, back up and restore capabilities of system configuration information as well as custom programs.
m. Verify schedules are set up and working.
n. Verify Owner stipulated security and permissions is set up and functional.
o. In concert with the Building Power Outage test, validate that critical GUI installations are properly powered by UPS and emergency outlets to keep it functional during a power outage. Validate that the space has adequate lighting to manage the building in the event of an outage.

19. Start-up and check out control air compressors and air drying and filtering systems in accordance with the appropriate section and with manufacturer’s instructions.
   a. Validate adequate deliver and pressures
   b. Validate adequate redundancy
   c. Validate max run time and cycle time vs manufacturer’s recommendations
   d. Validate that routing of the compressed air does not result in condensation at any point in the system when used with the specified drier
   e. Check all PRVs both primary and back up to ensure adequate functionality and maintenance of downstream pressure


21. Verify proper interface with control panels of equipment with self-contained controls that are being monitored by the BAS.

B. Submit Start-Up Documentation. This shall be completed, submitted, and approved prior to demonstration and Acceptance Phase.

2.2 SENSOR CHECKOUT AND CALIBRATION

A. General Checkout: Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading of each other for pressure. Tolerances for critical applications may be tighter.

B. Calibration: Calibrate all sensors using one of the following procedures:
1. Sensors Without Transmitters—Standard Application. Make a reading with a calibrated test instrument within 6 inches of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20% of the expected range.

2. Sensors With Transmitters—Standard Application. Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer’s resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the OI. Record all values and recalibrate controller as necessary to conform to tolerances. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

C. Sensor Tolerance: Sensors shall be within the tolerances specified for the device.

2.3 LOOP TUNING

A. For all control loops, Contractor shall tune the loops to ensure the fastest stable response without hunting, offset or overshoot with tolerances defined above. Contractor shall introduce upsets to the load when possible to affect response. Otherwise, setpoints can be changed to affect the response.

B. Generally tune loops during periods of high gain.

C. Document all parameters either by capturing text, short interval trends, or screen shots of trend graph documenting the final response.

2.4 COIL VALVE LEAK CHECK

A. Verify proper close off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit. Calibrate air temperature sensors on each side of coil to be within 0.5°F of each other. Via the OI, command the valve to close. Energize fans. After 5 minutes, observe air temperature difference across coil. If a temperature difference is indicated, and the piping surface temperature entering the coil is within 3°F of the water supply temp, leakage is probably occurring. If it appears that it is occurring, close the isolation valves to the coil to ensure the conditions change. If they do, this validates the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.

2.5 VALVE STROKE SETUP AND CHECK

A. For all valve and actuator positions checked, verify the actual position against the OI readout.

B. Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command valve to a few intermediate positions. If actual valve position doesn’t reasonably correspond, replace actuator or add pilot positioner (for pneumatics)
2.6 **ALARM SETPOINT COORDINATION**

A. The Contractor shall prepare a list of all conceptual point types and recommend the types and recommended alarming strategies and setpoint for review of CxA and Owner. Owner shall use this alarm list to provide direction to Contractor for alarm strategies and setpoints. Alarm list shall be provided at least two months prior to the first functional test. Contractor shall have alarm setpoints entered prior to functional testing. Omitting an alarm setting, using the wrong strategy, or entering the wrong setpoints will be considered a failure from the perspective of the functional test.

2.7 **GRAPHIC COORDINATION**

A. The Contractor shall prepare all graphics (only one example graphic is required for typical systems like terminal units) with points embedded for review of CxA and Owner. Owner shall use these graphics to provide direction to Contractor for the required final graphic. All final graphics must be complete and active before functional testing. Any deviation from the approved graphics will be considered a failure from the perspective of the functional test.

2.8 **BAS DEMONSTRATION**

A. Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of the CxA and Owner. Schedule the demonstration with the Owner's representative 1 week in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved. If the Work fails to be demonstrated to conform with Contract specifications, so as to require scheduling of additional site visits by the CxA for re-demonstration, Contractor shall reimburse Owner for costs of subsequent CxA site visits.

B. The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments, ladders, etc. Contractor supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the job site.

C. Demonstration shall typically involve small representative samples of systems/equipment randomly selected by the Owner and CxA.

D. The system shall be demonstrated following the same procedures used in the Start-Up Test by using the approved Commissioning Checklists. Demonstration shall include, but not necessarily be limited to, the following:
   1. Demonstrate that required software is installed on BAS workstations. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted and approved.
   2. Demonstrate that points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified.
   3. Demonstrate that remote dial-up communication abilities are in accordance with these Specifications.
   4. Demonstrate correct calibration of input/output devices using the same methods specified for the start-Up tests. A maximum of 10 percent of I/O points shall be selected at random by CxA and/or Owner for demonstration. Upon failure of any device to meet the specified end-to-end accuracy, an additional 10 percent of I/O points shall be selected at random by CxA for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified end-to-end accuracy.
   5. Demonstrate that all BAS and other software programs exist at respective field panels. The BAS programming and point database shall be as submitted and approved.
   6. Demonstrate that all BAS programs accomplish the specified sequences of operation.
   7. Demonstrate that the panels automatically recover from power failures, as specified.
8. Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels’ response to LAN communication failures meets the requirements of these Specifications.

9. Identify access to equipment selected by CxA. Demonstrate that access is sufficient to perform required maintenance.

10. Demonstrate that required trend graphs and trend logs are set up per the requirements. Provide a sample of the data archive. Indicate the file names and locations.

E. BAS Demonstration shall be completed and approved prior to Functional Performance Testing. CxA shall determine if the system is ready for Functional Performance Testing and document any problems requiring Contractor attention.

1. If the systems are not ready for Functional Performance Testing, Contractor shall correct problems and provide notification to the Owner’s representative that all problems have been corrected. The Acceptance Period shall be restarted at a mutually scheduled time for an additional one week period. This process shall be repeated until CxA issues notice that the BAS is ready for Functional Performance Testing.

F. Any tests successfully completed during the BAS Demonstration will be recorded as ‘Passed’ for the Functional Performance Testing and will not have to be re-accomplished.

2.9 FUNCTIONAL PERFORMANCE TESTING

A. Requirements for assistance with Functional Performance Testing are specified in the Section 01 91 00, Section 23 08 00 and Section 26 08 00. Provide assistance during Functional Performance Testing per the Section 01 91 10.

2.10 BAS ACCEPTANCE PHASE AND OBSERVATION PERIOD

A. BAS Acceptance Phase: BAS Acceptance Phase consists of the Functional Performance Testing process of the BAS by the CxA and shall begin after approval of the BAS Demonstration and prior to issuance of Substantial Completion. Acceptance Phase for the BAS shall not be scheduled until all HVAC systems are in operation, the Start-Up Documentation has been reviewed, all required cleaning and lubrication has been completed (i.e., filters changed, piping flushed, strainers cleaned, etc.), and TAB report has been submitted and approved. Acceptance Phase and its approval to begin will be performed on a system-by-system basis if mutually agreed upon by Contractor and Owner.

B. BAS Observation Period: After Functional Performance Testing, the BAS shall be shown to operate properly for 2 weeks without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these specifications. At the end of the two weeks, BAS Contractor shall forward the trend logs to the CxA for review.

C. During the Acceptance Phase, the Contractor shall maintain a hard copy log of all alarms generated by the BAS. For each alarm received, Contractor shall diagnose the cause of the alarm, and shall list on the log for each alarm, the diagnosed cause of the alarm, and the corrective action taken. If in the Contractor’s opinion, the cause of the alarm is not the responsibility of the Contractor, Contractor shall immediately notify the Owner's representative.

D. During the Acceptance Phase, the Contractor shall maintain all controller network and workstation hardware and software in a state that will allow remote access by CxA to trend logs as specified below.
2.11 BAS TREND REQUIREMENTS

A. The BAS Contractor shall configure and analyze all trends as listed below.

B. Trends are historical archives on computer disks that document the operation of the systems and equipment. Trends can be time-series (interval) recordings of system I/O parameters or change-of-value (COV) based trends that record when a system value changes by more than a specified threshold.

C. CxA will analyze trend logs of the system operating parameters to evaluate normal system functionality. The requirements of the trending are specified below. Contractor shall establish these trends, ensure they are being stored properly, and forward the data in electronic format to the CxA.

D. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field. Recorded parameters for a given piece of equipment or component shall be trended at the same time intervals and be presented in a maximum of two separate two dimensional formats with time being the vertical axis and field name being the horizontal axis. Data shall be forwarded in one of the following formats.

1. Microsoft Access Database (.mdb)
2. Microsoft Excel Spreadsheet (.xls)
3. Comma Separated Value (.csv or .txt), preferably with quotes delimiting text fields and # delimiting date/time fields.

E. Sample times indicated as COV (±) mean that the changed parameter only needs to be recorded whenever the value changes by the amount listed. When output to the trend file, the latest recorded value shall be listed along with the time increment record. If the BAS does not have the capability to record based on COV, the parameter shall be recorded based on the time interval common to other point trends for the system.

F. Contractor shall provide the CxA with required passwords, phone numbers, etc. to allow the CxA access to the trend log data and allow downloading to a remote location. Contractor shall also provide step-by-step written instructions for accessing the data.

G. Trending Requirements: All I/O points on primary equipment shall be trended throughout the Cx process on 10 min. intervals for analog values and change-of-value for binary values. Trends shall include but are not necessarily limited to the following points:

1. Outside air temperature
2. Outside air relative humidity
3. Outside air enthalpy
4. Cooling tons
5. All sensed hydronic temperatures
6. All sensed air temperatures and relative humidity measurements on primary equipment
7. All damper outputs on primary equipment
8. All valve outputs on primary equipment
9. All sensed fan volumes (flow) on primary equipment
10. All inputs and outputs to VSDs
11. Return (or exhaust) air temperature on each air handler
12. All safety indications
13. Status on all primary equipment
14. All air and water pressures on primary equipment or systems
15. Zone temperatures
16. Steam flow
17. Electricity consumption where monitored.
18. Natural gas flows
19. Converter steam valves and hot water temperatures
20. Steam supply pressures and temperatures.
21. Basically all points on primary equipment and selected sampling of terminal points unless approved otherwise

H. Trending used to document ongoing FPTs may occur at a more frequent interval. Consult with the CxA to determine the required intervals for functional testing and modify intervals as required.

2.12 TREND GRAPHS

A. Trend graphs shall be used during Functional Performance Testing to facilitate and document testing. Contractor shall prepare controller and workstation software to display graphical format trends throughout the Acceptance Phase. Trend graphs shall demonstrate compliance with contract documents. Trended values and intervals shall be the same as those specified for the Functional Performance Tests.

B. Lines shall be labeled and shall be distinguishable from each other by using either different line types or different line colors.

C. Indicate engineering units of the y-axis values; e.g. degrees F., inches w.c., Btu/lb, percent wide open, etc.

D. The y-axis scale shall be chosen so that all trended values are in a readable range. Do not mix trended values on one graph if their unit ranges are incompatible.

E. Trend outside air temperature, humidity, and enthalpy during each period in which any other points are trended.

F. All points trended for one HVAC subsystem (e.g. air handling unit, chilled water system, etc.) shall be trended simultaneously and on a common trend period.

G. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.

H. This Contractor is responsible to set-up the trend graphs for each PID loop as described above.

2.13 WARRANTY PHASE - OPPOSITE SEASON TRENDING AND TESTING

A. Trending: Throughout the Warranty Phase, trend logs shall be maintained as required for the Acceptance Phase. BAS Contractor shall forward archived trend logs to the CxA for review upon CxA request. CxA will review these and notify BAS Contractor of any warranty work required.

B. Opposite Season Testing: Within 6 months of completion of the Acceptance Phase, CxA shall schedule and conduct Opposite Season Functional Performance Testing. The BAS Contractor shall support this testing and remedy any deficiencies identified.

2.14 SOFTWARE OPTIMIZATION ASSISTANCE

A. The Contractor shall provide the services of a BAS technician as specified above at the project site to be at the disposal of the CxA. The purpose of this requirement is to make changes, enhancements and additions to control unit and/or workstation software that have been identified by the CxA during the construction and commissioning of the project and that are beyond the specified Contract requirements. The cost for this service shall be included with the
bid. Requests for assistance shall be for contiguous or non-contiguous 8-hour days, unless otherwise mutually agreed upon by Contractor, CxA, and Owner. The Owner’s representative shall notify Contractor 2 days in advance of each day of requested assistance.

B. The BAS technician provided shall be thoroughly trained in the programming and operation of the controller and workstation software. If the BAS technician provided cannot perform every software task requested by the CxA in a timely fashion, Contractor shall provide additional qualified personnel at the project site as requested by the CxA to meet the total specified requirement on-site.

2.15 BAS OPERATOR TRAINING

A. Provide up to 6 complete sets of User Manuals (hard copy and one electronic copy) to be used for training.

B. BAS Contractor shall submit a Training Plan per the requirements of Div 01 to the CM who will forward it to the A/E and CxA for review.

C. On Site Training: Provide services of BAS Contractor’s qualified technical personnel for five 8-hour days to instruct Owners personnel in operation and maintenance of the BAS. Instruction shall be in classroom setting at the project site for appropriate portions of the training. Training may be in non-contiguous days at the request of the Owner. The Owner’s representative shall notify Contractor 1-week in advance of each day of requested training. The Contractor’s designated training personnel shall meet with the A/E, CxA and Owner’s representative for the purpose of discussing and fine-tuning the training agenda prior to the first training session. Training agenda shall be as follows:

1. Basic Operator Workstation Training – 8 hours for all potential users of the OWS in 4-hour non-contiguous segments:
   a. Brief walk-through of building, including identification of all controlled equipment and condensed demonstration of controller portable and built-in operator interface device display capabilities.
   b. Brief overview of the various parts of the BAS O&M manuals, including hardware and software programming and operating publications, catalog data, controls installation drawings, and BAS programming documentation.
   c. Demonstration of workstation login/logout procedures, password setup, and exception reporting.
   d. Demonstration of workstation menu penetration and broad overview of the various workstation features.
   e. Overview of systems installed.
   f. Present all site-specific naming conventions and points lists, open protocol information, configuration databases, back up sequences, upload/download procedures, etc.
   g. Overview of scheduling procedures.
   h. Overview of alarm features, including how to acknowledge, respond to, and archive alarms, and how to access further information from them.
   i. Overview of trend features, including how to set up and view trends.
   j. Overview of workstation reporting features and introductory level report generation and scheduling.

2. BAS Technician Training: Two 24-hour training sessions that can be in 4-hour non-contiguous segments for individuals who will troubleshoot the system hardware, I/O devices, and the systems in general.
   a. General review of sequence of operation and control logic for the project site, including standalone and fail safe modes of operation;
   b. Uploading/downloading and backing up controller configuration and application programs;
c. Review of installed components including all communication devices, controllers, I/O, etc., and how to install/replace, maintain, commission, and diagnose them;
d. Introduction to controller programming and overview of the programming application interface;
e. Defining trends, generating graphs in real time; archiving trends, accessing historical archive and generating reports from them;
f. Introductory network administration;
g. Introduction to creating and editing graphics;
h. Review of setpoint optimization and fine-tuning concepts;
i. OI use and maintenance;
j. Web page creation as applicable.

3. System Administrator Training: One 8-hour session that may be done in two 4-hour segments on non-contiguous days. Target audience is the person who will be maintaining the system from an IT perspective as well as Owners IT personnel. Agenda shall be as follows:
   a. Overview of system architecture including all routers, bridges, repeaters, gateways, communications protocols, servers, controllers, etc.;
   b. Overview of and recommendations for backing up and restoring the system configuration database;
   c. Server maintenance;
   d. Security Management: Assigning passwords and rights for various users on the server, workstations and GUI software.

4. Final Systems Operation Training
   a. The BAS Contractor shall conduct Final Systems Operation Training in accordance with Section 01 91 00.
   b. Final Systems Operation Training provides the Owner and Operators a training session on whole-building operation. It shall focus primarily on BAS control of building systems and operation and its impact on building performance. System interactions shall be presented and discussed (such as a combined air handler, chiller, boiler, and terminal unit system), along with a detailed presentation of the sequences of operation and their relationship to the BAS. This training shall be conducted by the BAC with assistance from the CxA, and shall be attended by the Owner, Operators, Contractor, Design Team, and by any other Cx Team members deemed necessary by the CxA or the Owner.
   c. The Record BAS Shop Drawings shall be provided as a handout for the training.
   d. Scheduling, attendees, and training methods shall be as specified in Section 01 91 00.

D. Advanced Off-Site BAS Training: Advanced BAS training shall be provided for one individual and be provided at an offsite training facility containing installations of the proposed system. BAS Contractor shall pay registration and materials fee and the Owner shall pay all other expenses. Training shall include:
   1. Standard offering of advanced training on all control programming applications.
   2. Standard offering of Advanced Installation, Configuration, Maintenance, and Network Administration.

END OF SECTION 230800
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Condensate-drain piping.

B. Related Sections include the following:

1. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
2. Division 25 Section "Building Automation System" for control valves also used for system balancing.

1.3 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Hot-Water Heating Piping: at 200 deg F.
2. Chilled-Water Piping: at 200 deg F.
3. Condensate-Drain Piping: 150 deg F.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Air control devices.
2. Hydronic specialties.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

C. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of
the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air control devices, hydronic specialties, and specialty-duty valves to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. DWV Copper Tubing: ASTM B 306, Type DWV.

C. Wrought-Copper Fittings: ASME B16.22.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. **Grooved-End Copper Fittings:** ASTM B 75, copper tube or ASTM B 584, bronze casting.

3. **Grooved-End-Tube Couplings:** Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, EPDM gasket rated for minimum 250 deg F for use with housing, and steel bolts and nuts.

D. **Copper Pressure-Seal Fittings:**

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   
   a. Stadler-Viega.

2. **Housing:** Copper.

3. **O-Rings and Pipe Stops:** EPDM.

4. **Tools:** Manufacturer's special tools.

5. **Minimum 200-psig working-pressure rating at 250 deg F.**

E. **Wrought-Copper Unions:** ASME B16.22.

2.2 **STEEL PIPE AND FITTINGS**

A. **Steel Pipe:** ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. **Cast-Iron Threaded Fittings:** ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. **Cast-Iron Pipe Flanges and Flanged Fittings:** ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

D. **Wrought-Steel Fittings:** ASTM A 234/A 234M, wall thickness to match adjoining pipe.

E. **Wrought Cast- and Forged-Steel Flanges and Flanged Fittings:** ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

   1. **Material Group:** 1.1.
   2. **End Connections:** Butt welding.
   3. **Facings:** Raised face.

F. **Grooved Mechanical-Joint Fittings and Couplings:**

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Anvil International, Inc.
   b. National Fittings, Inc.
   c. S. P. Fittings; a division of Star Pipe Products.
   d. Victaulic Company.
2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

3. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

G. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.


E. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Flanges:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

D. Dielectric-Flange Kits:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Pipeline Seal and Insulator, Inc.

2. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

3. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

E. Dielectric Couplings:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Calpico, Inc.
   b. Lochinvar Corporation.
   c. Galvanized-steel coupling with Inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

2.5 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 25 Section "Building Automation System."

2.6 AIR CONTROL DEVICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   1. Amtrol, Inc.
   2. Armstrong Pumps, Inc.
   3. Bell & Gossett Domestic Pump; a division of ITT Industries.
   4. Taco.

B. Manual Air Vents:

   1. Body: Bronze.
   2. Internal Parts: Nonferrous.
   3. Operator: Screwdriver or thumbscrew.
   4. Inlet Connection: NPS 1/2.
   7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:
1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
4. Inlet Connection: NPS 1/2.

D. CWP Rating: 150 psig. Expansion Tanks:
1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.

E. Tangential-Type Air Separators:
1. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
5. Size: Match system flow capacity.

2.7 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:
1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

B. Basket Strainers:
1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

C. Spherical, Rubber, Flexible Connectors:
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.
D. Diaphragm-Operated Safety Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump; a division of ITT Industries.
   d. Conbraco Industries, Inc.
   e. Spence Engineering Company, Inc.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
8. Inlet Strainer: stainless steel, removable without system shutdown.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

E. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flow Design Inc.
   b. Griswold Controls.
   c. Hays Fluid Controls

2. Body: Brass or ferrous metal.
3. Piston and Spring (Cartridge) Assembly: Stainless steel, tamper proof, self cleaning, and removable.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
9. Maximum Operating Temperature: 200 deg F.

F. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
2. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints or pressure seal.
   2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

C. Hot-water heating piping installed belowground and within slabs shall be the following:
   1. Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

D. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
   1. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure seal joints.
   2. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

E. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure seal joints.
   2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

F. Makeup-water piping installed aboveground shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure seal joints.

G. Makeup-Water Piping Installed Belowground and within Slabs: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

H. Condensate-Drain Piping: Type M or DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

I. Air-Vent Piping:
   1. Inlet: Same as service where installed.
   2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

J. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install throttling-duty valves at each branch connection to return main.

C. Install check valves at each pump discharge and elsewhere as required to control flow direction.

D. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

E. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install piping on warm side of building insulation. Do not install piping where subject to freezing.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

M. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

N. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
O. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
2. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
3. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
4. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
5. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
6. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.
D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.


G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.
C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

E. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as heat exchangers.
7. Verify lubrication of motors and bearings.

END OF SECTION 23 21 13
1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary
   Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Separately-coupled, end-suction centrifugal pumps.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated
   capacities, operating characteristics, furnished specialties, final impeller dimensions, and
   accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.
   1. Show pump layout and connections.
   2. Include setting drawings with templates for installing foundation and anchor bolts and
      other anchorages.
   3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and
   maintenance manuals.

PART 2 - PRODUCTS

2.1 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering
   products that may be incorporated into the Work include, but are not limited to, the following:
   1. Armstrong Pumps Inc.
   2. Aurora Pump; Division of Pentair Pump Group.
   3. ITT Corporation; Bell & Gossett.
B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

C. Pump Construction:
   1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
   2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
   3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
   4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
   5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor:
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   3. Comply with requirements of Division 23 Section "Variable-Frequency Motor Controllers"
   4. Provide grounding device for motor shaft of all motors used with variable frequency controllers.

2.2 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:
   1. Angle pattern.
   2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
   3. Bronze startup and bronze or stainless-steel permanent strainers.
   4. Bronze or stainless-steel straightening vanes.
   5. Drain plug.
   6. Factory-fabricated support.

B. Triple-Duty Valve:
1. Brass gage ports with integral check valve and orifice for flow measurement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Equipment Mounting: Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases specified in Division 03 Section “Cast-in-Place Concrete.”
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.
   2. Construct concrete bases 4 inches high and extend base not less than 6 inches in all directions beyond the maximum dimensions of base-mounted pumps unless otherwise indicated or unless required for seismic-anchor support.
   3. Minimum Compressive Strength: 3000 psi at 28 days.

3.3 ALIGNMENT

A. Perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.
3.4 CONNECTIONS

A. Comply with requirements for piping specified in Division 23 Section "Steam and Condensate Heating Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install triple-duty valve on discharge side of pumps.

F. Install suction diffuser and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:
   a. Verify bearing lubrication.
   b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
   c. Verify that pump is rotating in the correct direction.
5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Open discharge valve slowly.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 23 21 23
SECTION 23 22 13 - STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes the following for LP steam and condensate piping:
      1. Pipe and fittings.
      2. Strainers.
      4. Steam traps.
      5. Thermostatic air vents and vacuum breakers.

1.3 DEFINITIONS
   A. LP Systems: Low-pressure piping operating at 15 psig or less as required by ASME B31.9.

1.4 PERFORMANCE REQUIREMENTS
   A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:
      1. LP Steam Piping: 100 psig
      2. Condensate Piping: 100 psig at 250 deg F.
      3. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
      4. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

1.5 ACTION SUBMITTALS
   A. Product Data: For each type of the following:
      1. Steam trap.
      2. Air vent and vacuum breaker.

1.6 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For valves, safety valves, steam traps, air vents, and vacuum breakers to include in emergency, operation, and maintenance manuals.
1.7 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."

B. Pipe Welding: Qualify processes and operators according to the following:
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in Part 3 piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   2. End Connections: Butt welding.
   3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

I. Stainless-Steel Bellows, Flexible Connectors:
   2. End Connections: Threaded or flanged to match equipment connected.
2.2 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

2.3 VALVES

A. Gate, Globe, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

2.4 STRAINERS

A. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
   4. Tapped blowoff plug.
   5. CWP Rating: 250-psig working steam pressure.

2.5 SAFETY VALVES

A. Cast-Iron Safety Valves:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. Spirax Sarco, Inc.
      c. Watts Water Technologies, Inc.
2. Disc Material: Forged copper alloy with bronze nozzle.
3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
7. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.

2.6 STEAM TRAPS

A. Float and Thermostatic Traps:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Hoffman Specialty; Division of ITT Industries.
   c. Spirax Sarco, Inc.
2. Body and Bolted Cap: ASTM A 126, cast iron.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.

2.7 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Hoffman Specialty; Division of ITT Industries.
   c. Spirax Sarco, Inc.
2. Body: Cast iron, bronze or stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
7. Maximum Temperature Rating: 350 deg F.

B. Vacuum Breakers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Hoffman Specialty; Division of ITT Industries.
   c. Spirax Sarco, Inc.

2. Body: Cast iron, bronze, or stainless steel.
5. O-ring Seal: EPR.
7. Maximum Temperature Rating: 350 deg F.

2.8 MOISTURE SEPARATORS

A. Moisture Separators:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Hoffman Specialty; Division of ITT Industries.
   c. Spirax Sarco, Inc.

2. Body: ASTM A 126, cast iron.
3. End Connections: Flanged or NPT.
4. Internal Baffles: cast with body.
5. Bushings: Malleable iron.
6. Plug: Malleable iron.
7. Plug gasket: Reinforced exfoliated graphite.
8. Maximum Operating Pressure: 188 psig at 428°F

PART 3 - EXECUTION

3.1 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping, NPS 2 and Smaller: Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. LP Steam Piping, NPS 2-1/2 through NPS 12: Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping above grade, NPS 2 and smaller, shall be the following:
1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

D. Condensate piping below grade, NPS 2 and smaller, shall be the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

3.2 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Install piping to allow application of insulation.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

J. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

K. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.
L. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

M. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

N. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.

O. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

R. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

S. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

T. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

U. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.

1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet.
2. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced, but to no less than NPS 4.

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

3.4 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, and full-port ball valve downstream from trap unless otherwise indicated.

3.5 MOISTURE SEPARATOR INSTALLATION

A. Install moisture separators in accessible locations as close as possible to connected equipment.

B. Install moisture separators upstream of heat exchanger control valves.
3.6 SAFETY VALVE INSTALLATION

A. Install safety valves according to ASME B31.9, "Building Services Piping."

B. Pipe safety-valve discharge without valves to atmosphere outside the building.

C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.7 HANGERS AND SUPPORTS

A. Install hangers and supports according to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with requirements below for maximum spacing.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.

C. Install hangers with the following maximum spacing and minimum rod sizes:

1. NPS 2: Maximum span, 13 feet; minimum rod size, 3/8 inch.
2. NPS 4: Maximum span, 17 feet; minimum rod size, 1/2 inch.
3. NPS 6: Maximum span, 21 feet; minimum rod size, 1/2 inch.

3.8 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.9 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

3.10 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.9, "Building Services Piping," and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Perform the following tests on steam and condensate piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

C. Prepare written report of testing.

END OF SECTION 23 22 13
SECTION 23 22 23 - STEAM CONDENSATE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes steam condensate pumps.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated. Indicate pump's operating point on curves. Include receiver capacity and material.

B. Shop Drawings: For each pump.
   1. Show pump layout and connections.
   2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 PRESSURE-POWERED PUMPS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   1. Armstrong Fluid Handling; Div. of Armstrong International, Inc.
   2. ITT Corporation; Domestic Pump Division.
   3. Spirax-Sarco Inc.
   4. Sterling.

B. Description: Factory-fabricated, pressure-powered pumps with mechanical controls, valves, piping connections, and accessories suitable for pumping steam condensate using compressed air.
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. ASME Compliance: Fabricate and label steam condensate receivers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. Configuration: Duplex pump with float-operated valve control. Receiver:

1. Pump Body: Cast iron, ASME rated to 125 psig.
2. Piping Connections: Threaded; for steam condensate, operating medium, vent, and indicated accessories.
3. Level Gage: Glass site gage with shutoff cocks.
4. Valves: Manufacturer's standard check valves on inlet and outlet.
5. Internal Parts: Stainless-steel float, springs, and actuating mechanism.

D. Receiver:

1. Factory mounted on steel supports.
2. Cast iron.
3. Threaded piping connections.
4. Water-level gage and dial thermometer.
5. Pressure gage at pump discharge.
6. Bronze fitting isolation valve between pump and receiver.
7. Lifting eyebolts.
8. Inlet vent and an overflow.

E. Pipe: ASTM A 53/A 53M, Type S, Grade B or ASTM A 106/A 106M; Schedule 80; seamless steel.

F. Fittings: ASME B16.1, Class 125 cast iron, threaded.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install pumps to provide access for periodic maintenance including removing impellers, couplings, and accessories.

B. Support pumps and piping separately so piping is not supported by pumps.
C. Install thermometers and pressure gages.

D. Equipment Mounting: Install pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases specified in Division 03 Section "Cast-in-Place Concrete."

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct bases to withstand, without damage to equipment, seismic force required by code.
3. Construct concrete bases 4 inches high and extend base not less than 6 inches in all directions beyond the maximum dimensions of pumps unless otherwise indicated or unless required for seismic-anchor support.
4. Minimum Compressive Strength: 3000 psi at 28 days.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Division 23 Section "Steam and Condensate Heating Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to machine, allow space for service and maintenance.

C. Install a globe and check valve and pressure gage before inlet of each pump and a gate and check valve at pump outlet.

D. Pipe drain to nearest floor drain for overflow and drain piping connections.

E. Install full-size vent piping to outdoors, terminating in 180-degree elbow at point above highest steam system connection or as indicated.

3.4 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Clean strainers.
3. Set steam condensate pump controls.
4. Set pump controls for automatic start, stop, and alarm operation.
5. Perform the following preventive maintenance operations and checks before starting:
   a. Set float switches to operate at proper levels.
   b. Set throttling valves on pump discharge for specified flow.
   c. Test pump controls and demonstrate compliance with requirements.
   d. Replace damaged or malfunctioning pump controls and equipment.
   e. Verify that pump controls are correct for required application.
6. Start steam condensate pumps according to manufacturer's written startup instructions.

END OF SECTION 23 22 23
SECTION 23 25 00 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following HVAC water-treatment systems:

1. Bypass chemical-feed equipment and controls.
2. Chemical treatment test equipment.
3. HVAC water-treatment chemicals.

1.3 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

B. RO: Reverse osmosis.

C. TDS: Total dissolved solids.

1.4 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including hot-water heating, shall have the following water qualities:

1. pH: Maintain a value within 9.0 to 10.5.
2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
3. Boron: Maintain a value within 100 to 200 ppm.
4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
6. TDS: Maintain a maximum value of 10 ppm.
9. Microbiological Limits:

   a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

1.5 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
   1. Bypass feeders.
   2. Chemical test equipment.
   3. Chemical material safety data sheets.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

B. Other Informational Submittals:


1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, water softeners, and controllers to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   1. GE Betz.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT
A. **Bypass Feeders:** Steel, 10-gauge minimum, with corrosion-resistant exterior coating, minimum 4-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cast iron cap with Buna N seat ring.

1. Capacity: 5 gal.

### 2.3 CHEMICAL TREATMENT TEST EQUIPMENT

A. **Corrosion Test-Coupon Assembly:** Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

1. Two-station rack for closed-loop systems.

### 2.4 CHEMICALS

A. Chemicals shall be an alkaline, buffered, nitrite-based corrosion inhibitor, maintained at proper levels to prevent corrosion to the system, compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 “Performance Requirements” Article.

### PART 3 - EXECUTION

#### 3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

#### 3.2 INSTALLATION

A. Install water testing equipment on wall near water chemical application equipment.

B. **Bypass Feeders:** Install in closed hydronic systems, including hot-water heating, and equipped with the following:

1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
2. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
3. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
4. Install a swing check on inlet after the isolation valve.

#### 3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.
C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23 Section "Hydronic Piping."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 23 Section "General-Duty Valves for HVAC Piping."

E. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping.
2. Pre-operational Cleaner: All systems shall be flushed with water prior to chemical cleaning. Use water meter to fill, record, and tag (permanent tag) the system with the actual system volume. Chemical cleaner shall be added to remove grease, mill oil, organic soil, flux, iron oxide etc. All terminal control valves and valves at end of runs ("dead legs") shall be opened so that cleaner is circulated through the whole system. After cleaning, all strainers shall be flushed, and strainer screens cleaned or replaced. Once closed loop is chemically cleaned, system shall be dumped and flushed with water so that all cleaning chemical is removed from the system.
3. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
4. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
5. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
6. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
7. Repair leaks and defects with new materials and retest piping until no leaks exist.

C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 25 00
SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
4. Sealants and gaskets.
5. Hangers and supports.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
3. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

B. Shop Drawings:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.
   3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
   4. Elevation of top of ducts.
   5. Dimensions of main duct runs from building grid lines.
   6. Fittings.
   7. Reinforcement and spacing.
   8. Seam and joint construction.
   9. Penetrations through fire-rated and other partitions.
  10. Equipment installation based on equipment being used on Project.
  11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
  12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.5 INFORMATIONAL SUBMITTALS
   A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
      1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
      2. Suspended ceiling components.
      3. Structural members to which duct will be attached.
      4. Size and location of initial access modules for acoustical tile.
      5. Penetrations of smoke barriers and fire-rated construction.
      6. Items penetrating finished ceiling including the following:
         a. Lighting fixtures.
         b. Air outlets and inlets.
         c. Speakers.
         d. Sprinklers.
         e. Access panels.
         f. Perimeter moldings.
         g. Projection Screens
   B. Field quality-control reports.

1.6 QUALITY ASSURANCE
   A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
   B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
B. Two-Part Tape Sealing System:
   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone
      activator to react exothermically with tape to form hard, durable, airtight seal.
   2. Sealant: Modified styrene acrylic.
   3. Water resistant.
   4. Mold and mildew resistant.
   5. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   7. Service Temperature: Minus 40 to plus 200 deg F.
   8. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless
      steel, or aluminum.
   9. For indoor applications, sealant shall have a VOC content of 250 g/L or less when
      calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   8. Service: Indoor or outdoor.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless
      steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.
   2. Type: S.
   3. Grade: NS.
   5. Use: O.
   6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when
      calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be
      rated for 10-inch wg static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings
      and fitting spigots.

2.4 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports:

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

   1. Where practical, install concrete inserts before placing concrete.
   2. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Duct system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

END OF SECTION 23 31 13
1. RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   2. Fire dampers.
   3. Smoke dampers.
   4. Combination fire and smoke dampers.
   5. Turning vanes.
   6. Remote damper operators.
   7. Duct-mounted access doors.
   8. Flexible connectors.
   10. Duct accessory hardware.

B. Related Requirements:
   1. Division 28 Section "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
   2. Product Data for Prerequisite EA 2: Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

   1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

      a. Special fittings.
      c. Control-damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.

e. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION


B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

   1. Galvanized Coating Designation: G60.

   2. Exposed-Surface Finish: Mill phosphatized.

B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Air Balance Inc.; a division of Mestek, Inc.
b. American Warming and Ventilating; a division of Mestek, Inc.
c. McGill AirFlow LLC.
d. Nailor Industries Inc.
e. Pottorff.
f. Ruskin Company.
g. Trox USA Inc.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized-steel, 0.064 inch thick.

7. Bearings:
   a. Oil-impregnated bronze or molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

B. Jackshaft:
   1. Size: 0.5-inch minimum diameter.
   2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
   3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:
   2. Include center hole to suit damper operating-rod size.
   3. Include elevated platform for insulated duct mounting.

2.4 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   1. Air Balance Inc.; a division of Mestek, Inc.
   2. Cesco Products; a division of Mestek, Inc.
4. Nailor Industries Inc.
5. Pottorff.
6. Ruskin Company.

B. Type: Static; rated and labeled according to UL 555 by an NRTL.

C. Fire Rating: 1-1/2 hours.

D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.05 thick, as indicated, and of length to suit application.
   2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.


2.5 SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Air Balance Inc.; a division of Mestek, Inc.
   2. Cesco Products; a division of Mestek, Inc.
   4. Nailor Industries Inc.
   5. Pottorff.
   6. Ruskin Company.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Provided by Fire Alarm Contractor and installed by Mechanical Contractor. Integral, factory wired for single-point connection.

D. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with welded interlocking, gusseted or mechanically attached corners and mounting flange.

E. Blades: Roll-formed, horizontal, interlocking or overlapping, 0.034-inch minimum thick, galvanized sheet steel.

F. Leakage: Class I.
G. Rated pressure and velocity to exceed design airflow conditions.

H. Mounting Sleeve: Factory-installed, 0.039-inch minimum thick, galvanized sheet steel; length to suit wall or floor application.

I. Damper Motors: Two-position action.

J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Electrical Connection: 24 V or 115 V, single phase, 60 Hz, coordinate with Electrical Contractor.

2.6 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
4. Nailor Industries Inc.
5. Pottorff.
6. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with welded interlocking, gusseted or mechanically attached corners and mounting flange.


G. Smoke Detector: Provided by Fire Alarm Contractor and installed by Mechanical Contractor

H. Blades: Roll-formed, horizontal, interlocking or overlapping, 0.034-inch minimum thick, galvanized sheet steel.

I. Leakage: Class I.
J. Rated pressure and velocity to exceed design airflow conditions.

K. Mounting Sleeve: Factory-installed, 0.039-inch minimum thick, galvanized sheet steel; length to suit wall or floor application.

L. Damper Motors: Two-position action.

M. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
   3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
   5. Electrical Connection: 24 V or 115 V, single phase, 60 Hz, coordinate with Electrical Contractor.

2.7 TURNING VANES

   A. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

2.8 REMOTE DAMPER OPERATORS

   A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      1. Pottorff.
      2. Ventfabrics, Inc.
      3. Young Regulator Company.

   B. Description: Cable system designed for remote manual damper adjustment.

   C. Wall-Box Mounting: Recessed.

   D. Wall-Box Cover-Plate Material: Stainless steel.

2.9 DUCT-MOUNTED ACCESS DOORS

   A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      1. American Warming and Ventilating; a division of Mestek, Inc.
      2. Cesco Products; a division of Mestek, Inc.
      3. Ductmate Industries, Inc.

1. Door:
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches.
   d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.

2.10 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. Ventfabrics, Inc.
B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

   1. Minimum Weight: 26 oz./sq. yd.
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   1. Minimum Weight: 24 oz./sq. yd.
   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: Minus 50 to plus 250 deg F.

2.11 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Flexmaster U.S.A., Inc.
   2. McGill AirFlow LLC.

B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   3. Temperature Range: Minus 10 to plus 160 deg F.
   4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

C. Flexible Duct Connectors:
   1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.12 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install duct accessories according to applicable details in SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install fire, smoke, and combination fire and smoke dampers according to UL listing.

G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from manual volume dampers, control dampers, and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   7. At each change in direction, except turns of less than 90-degrees, and at maximum 50-foot spacing.
   8. Upstream and downstream from turning vanes.
   9. Control devices requiring inspection.
   10. Elsewhere as indicated.

H. Install access doors with swing against duct static pressure.

I. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches .
   2. Two-Hand Access: 12 by 6 inches .

J. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

K. Install flexible connectors to connect ducts to equipment.

L. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
M. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

N. Connect flexible ducts to metal ducts with draw bands.

O. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00
SECTION 23 34 23 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Ceiling-mounted ventilators.
   2. In-line centrifugal fans.
   3. Residential grade kitchen exhaust fan.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.
B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Fan speed controllers.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.8 COORDINATION

A. Coordinate size and location of structural-steel support members.

PART 2 - PRODUCTS

2.1 CEILING-MOUNTED VENTILATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Loren Cook Company.
3. PennBarry.

B. Housing: Steel, lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

D. Grille: Metal, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

2.2 IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Loren Cook Company.
3. PennBarry.

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories:
   1. Companion Flanges: For inlet and outlet duct connections.
   2. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
   3. Comply with requirements of Division 23 Section "Variable-Frequency Motor Controllers."
   4. Provide grounding device for motor shaft of all motors used with variable frequency controllers.

2.4 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using elastomeric mounts having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
D. Support suspended units from structure using threaded steel rods and elastomeric hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Install units with clearances for service and maintenance.

F. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Verify lubrication for bearings and other moving parts.
7. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
8. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
9. Shut unit down and reconnect automatic temperature-control operators.
10. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.
3.4 ADJUSTING

A. Adjust belt tension.

B. Comply with requirements in Division 23 Section "Testing, Adjusting, andBalancing for HVAC" for testing, adjusting, and balancing procedures.

C. Replace fan and motor pulleys as required to achieve design airflow.

D. Lubricate bearings.

END OF SECTION 23 34 23
1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Shutoff, single-duct air terminal units.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
   1. Air terminal units.
   2. Liners and adhesives.
   3. Sealants and gaskets.
B. LEED Submittals:
   1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - “Systems and Equipment.”
C. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.
   3. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Size and location of initial access modules for acoustic tile.
   3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.1 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Environmental Technologies, Inc.
2. METALAIRE, Inc.
3. Nailor Industries Inc.
5. Titus.
7. Tuttle & Bailey.

B. Casing: 0.034-inch steel, single wall.

1. Casing Lining: Non-fibrous "IAQ" type internal insulation.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Low leakage, gasketed, factory installed access door between damper and heating coil for access to parts requiring service, adjustment, or maintenance.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
D. **Hydronic Coils:** Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

E. **Controls:** The controller/actuator and temperature sensors shall be provided to the factory by the BAS vendor for installation by the air terminal unit provider.

F. Include precision airflow sensor to accurately and reliably control full range of airflow in a stable, non-hunting manner from absolute minimum required for minimum zone ventilation to maximum design airflow. Sensor shall be factory calibrated from 0 to 3000 fpm to NIST-traceable volumetric standards to provide accurate, repeatable airflow measurement from zero flow. Accuracy shall be within +/- 2% of airflow reading. Repeatability shall be within 0.25% of reading. Sensor assembly shall be UL listed and include a calibrated probe, integral enclosure and mounting brackets for simple installation. A DIP-switch user interface shall allow for field selection of airflow or equivalent velocity pressure output, four full-scale measurement range options and analog outputs for interface with BAS.

1. Specifying the precision airflow sensor allows for more accurate demand controlled ventilation compliance with ASHRAE 62.1 and may qualify for acquisition of LEED Energy and Atmosphere and Indoor Environmental Quality credits.

2. **Acceptable Manufacturer:** Ebtron ELF or sensor of equal performance.

### 2.2 HANGERS AND SUPPORTS

A. **Hanger Rods for Noncorrosive Environments:** Cadmium-plated steel rods and nuts.

B. **Steel Cables:** Galvanized steel complying with ASTM A 603.

C. **Steel Cable End Connections:** Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

D. **Air Terminal Unit Attachments:** Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. **Trapeze and Riser Supports:** Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

#### 3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
B. Building Attachments: Concrete inserts, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

C. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."

D. Make connections to air terminal units with flexible connectors complying with requirements in Division 23 Section "Air Duct Accessories."

3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safety controls. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 23 36 00
SECTION 23 37 13 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Rectangular and square ceiling diffusers.
2. Louver face diffusers.
3. Linear bar diffusers.
4. Linear slot diffusers.
5. Modular core supply grilles.
6. Adjustable bar registers and grilles.
7. Fixed face registers and grilles.
8. Linear bar grilles.

B. Related Sections:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
3. The air terminal submittal shall include a complete tabulation of all devices identified by room number and listing the model, velocity, cfm, throw, pressure drop, sound level and flow factor and/or core area in square feet.
4. The submittal shall also include the manufacturer's recommendations for air balancing procedures for the devices submitted.

PART 2 - PRODUCTS – SEE SCHEDULE ON DRAWINGS

2.1 MANUFACTURERS:
A. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Hart & Cooley Inc.
   b. METALAIRE, Inc.
   c. Nailor Industries Inc.
   d. Price Industries.
   e. Titus.
   f. Tuttle & Bailey.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13
SECTION 23 57 00 - HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes plate heat exchangers.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
B. Shop Drawings: Signed and sealed by a qualified professional engineer. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.

1.4 INFORMATIONAL SUBMITTALS
A. Source quality-control reports.
B. Field quality-control reports.
C. Sample Warranty: For manufacturer's warranty.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GASKETED-PLATE HEAT EXCHANGERS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Alfa Laval Inc.
2. ITT Corporation; Bell & Gossett.

B. Configuration: Freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets.

C. Frame:
   1. Capacity to accommodate 20 Insert number percent additional plates.
   2. Painted carbon steel with provisions for anchoring to support.

D. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.

E. End-Plate Material: Painted carbon steel.

F. Tie Rods and Nuts: Steel or stainless steel.

G. Plate Material: 0.024 inch minimum thick before stamping; Type 316 stainless steel.

H. Gasket Materials: Glue free.

I. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.
   1. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
   2. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

2.2 ACCESSORIES

A. Miscellaneous Components for Steam Unit: Strainers, steam-control valve, steam trap, valves, pressure gage, thermometer, and piping.

B. Pressure Relief Valves: Cast iron, ASME rated and stamped.

2.3 SOURCE QUALITY CONTROL


B. Hydrostatically test heat exchangers to minimum of one and one-half times pressure rating before shipment.

C. Heat exchangers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas for compliance with requirements for installation tolerances and for structural
rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.

B. Examine roughing-in for heat-exchanger piping to verify actual locations of piping connections
before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GASKETED-PLATE HEAT-EXCHANGER INSTALLATION

A. Install gasketed-plate heat exchanger on custom-designed wall supports anchored to structure
as indicated on Drawings.

B. Install metal shroud over installed gasketed-plate heat exchanger according to manufacturer's
written instructions.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate
general arrangement of piping, fittings, and specialties.

B. Comply with requirements for steam and condensate piping specified in Division 23 Section
"Steam and Condensate Heating Piping."

C. Maintain manufacturer's recommended clearances for tube removal, service, and maintenance.

D. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat

E. Install shutoff valves at heat-exchanger inlet and outlet connections.

F. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full
size of valve connection, to floor drain.

G. Install vacuum breaker at heat-exchanger steam inlet connection.

H. Install pressure gages on heat-exchanger and heating-fluid piping. Comply with requirements
for pressure gages specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service
representative:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest
until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls
and equipment.

B. Heat exchanger will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.
3.5 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

END OF SECTION 23 57 00
SECTION 23 73 13 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Variable-air-volume, single-zone air-handling units.

1.3 ACTION SUBMITTALS

A. Product Data: For each air-handling unit indicated.
   1. Unit dimensions and weight.
   2. Cabinet material, metal thickness, finishes, insulation, and accessories.
   3. Fans:
      a. Certified fan-performance curves with system operating conditions indicated.
      b. Certified fan-sound power ratings.
      c. Fan construction and accessories.
      d. Motor ratings, electrical characteristics, and motor accessories.
   4. Certified coil-performance ratings with system operating conditions indicated.
   5. Filters with performance characteristics.

B. LEED Submittals:
   1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - “Systems and Equipment.”

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
   2. Support location, type, and weight.
   3. Field measurements.

B. Source quality-control reports.

C. Field quality-control reports.
1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
F. Comply with NFPA 70.

1.7 COORDINATION
A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Carrier Corporation; a member of the United Technologies Corporation Family.
   2. Engineered Air.
   3. Trane; American Standard Inc.
   4. YORK International Corporation.

2.2 UNIT CASINGS
A. General Fabrication Requirements for Casings:
   1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
   2. Casing Joints: Sheet metal screws or pop rivets.
   3. Sealing: Seal all joints with water-resistant sealant.
   5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
B. Casing:
1. Outside Casing: Galvanized steel, minimum 0.052 inch thick.
2. Inside Casing: Galvanized steel, perforated at fan sections, minimum 0.052 inch thick.
3. Floor Plate: Galvanized steel, minimum 0.052 inch thick.
4. Insulation Thickness: 2 inches.
5. Static-Pressure Classifications for Unit Sections before Fans: 4-inch wg.
6. Static-Pressure Classifications for Unit Sections after Fans: 6-inch wg.

C. Access Doors:
1. Access Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
2. Access Doors:
   a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
   b. Gasket: Neoprene, applied around entire peripheries of panel frames.
   c. Size: Full height of unit casing up to a maximum height of 60 inches.
3. Service Light: Fixture complete with energy efficient, long-life fluorescent lamp and switched junction box located adjacent to door. UL listed for wet locations.
   a. Locations: Each section accessed with door.

D. Condensate Drain Pans:
1. Fabricated with at least one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and to direct water toward drain connection.
   a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
   b. Depth: A minimum of 2 inches deep.
2. Double-wall, galvanized-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
3. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
5. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.3 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
2. Shafts: Solid, designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
   a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
   b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutooff and spun-metal inlet bell.
1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Horizontal-Flanged, Split Housing: Bolted construction.
3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.

4. Flexible Connector: Factory fabricated with a fabric strip [3-1/2 inches] [5-3/4 inches] wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized-steel sheet or 0.032-inch- thick aluminum sheets; select metal compatible with casing.
      1) Fabric Minimum Weight: 26 oz./sq. yd..
      2) Fabric Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
      3) Fabric Service Temperature: Minus 40 to plus 200 deg F.

C. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.

D. Fan Shaft Bearings:
   1. Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and 2-piece, cast-iron housing with an L10 rated life of 200,000 hours. Extended grease lines to a safe and readily accessible location outside the unit with 1/8" steel tubing and flush plugs with relief set at 5 psig.

E. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.

F. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
   2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
   4. Provide grounding device for motor shaft of all motors used with variable frequency controllers.

G. Variable Frequency Controllers:
   1. Comply with requirements in Division 23 Section Variable-Frequency Motor Controllers for HVAC Equipment.

2.4 COIL SECTION

A. General Requirements for Coil Section:
   1. Comply with ARI 410.
   2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
   3. Coils shall not act as structural component of unit.

B. Water Coils:
   1. Coil Type: Self-draining.
   2. Piping Connections: Same end of coil.
   3. Tube Material: Copper.
   4. Fin Type: Plate.
   5. Fin Material: Aluminum.
   6. Fin and Tube Joint: Mechanical bond.
2.5 **AIR FILTRATION SECTION**

A. General Requirements for Air Filtration Section:
   1. Comply with NFPA 90A.
   2. Provide minimum arestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   3. Filters shall have separate holding frame with side access and slide out frames properly sized in accordance with filter manufacturers' guidelines. Frames shall be located to permit removal of entire frame for filter replacement.

2.6 **DAMPERS**

A. Damper and Damper Operators: Coordinate with provider and with requirements in Division 23 Section "Instrumentation and Control for HVAC."

B. Combination Filter and Mixing Section:
   1. Cabinet support members shall hold 2-inch-thick, pleated, flat, permanent or throwaway filters.
   2. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

2.7 **CAPACITIES AND CHARACTERISTICS - SEE EQUIPMENT SCHEDULE ON DRAWINGS**

2.8 **SOURCE QUALITY CONTROL**

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

**PART 3 - EXECUTION**

3.1 **EXAMINATION**

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
3.2 INSTALLATION

A. Equipment Mounting: Install air-handling units on concrete bases without vibration isolation devices. Secure units to anchor bolts installed in concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

2. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Connect duct to air-handling units with flexible connections. Comply with requirements in Division 23 Section "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. **Leak Test:** After installation, fill water coils with water, and test coils and connections for leaks.

2. **Fan Operational Test:** After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

D. Prepare test and inspection reports.

### 3.5 **STARTUP SERVICE**

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connection to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.
7. Verify that face-and-bypass dampers provide full face flow.
8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
10. Verify that proper thermal-overload protection is installed for electric coils.
11. Install new, clean filters.
12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

### 3.6 **ADJUSTING**

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

### 3.7 **CLEANING**

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally.
to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

PART 4 - BAS FIGURES

BAS FIGURES: Figure 1 and Figure 2 follow this page.
Figure 1: Building Automation System with Automated Logic Corporation product:
Figure 2: Building Automation System with Johnson Controls Inc. NAE product:

Johnson Controls System Architecture

END OF SECTION 23 73 13
SECTION 23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary
   Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes split-system air-conditioning and heat-pump units consisting of separate
   evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include rated capacities, operating
   characteristics, and furnished specialties and accessories. Include performance data in terms
   of capacities, outlet velocities, static pressures, sound power characteristics, motor
   requirements, and electrical characteristics.
B. LEED Submittals:
   1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants
      comply.
C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required
      clearances, method of field assembly, components, and location and size of each field
      connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.
B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For split-system air-conditioning units to include in
   emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:
   1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:
   a. For Compressor: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
3. Trane; a business of American Standard companies.
4. YORK; a Johnson Controls company.

2.2 INDOOR UNITS 5 TONS OR LESS

A. Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.
   a. Insulation: Faced, glass-fiber duct liner.
   b. Drain Pans: Galvanized steel, with connection for drain; insulated.

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.

3. Fan: Direct drive, centrifugal.

4. Fan Motors:
   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
5. Air Filtration Section:
   a. General Requirements for Air Filtration Section:
      1) Comply with NFPA 90A.
      2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
      3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
   b. Disposable Panel Filters:
      1) Factory-fabricated, viscous-coated, flat-panel type.
      2) Thickness: 1 inch.
      3) Arrestance according to ASHRAE 52.1: 80.
      4) Merv according to ASHRAE 52.2: 5.
      5) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
      6) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.3 INDOOR UNITS (6 TONS OR MORE)
A. Evaporator-Fan Components:
   1. Cabinet: Enamed steel with removable panels on front and ends in color selected by Architect.
      a. Insulation: Faced, glass-fiber duct liner.
   2. Condensate Drain Pans:
      a. Fabricated with minimum one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
         1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
         2) Depth: A minimum of 2 inches deep.
      c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple.
      d. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
   5. Fan Motors:
      a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
      b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
c. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

6. Air Filtration Section:
   a. General Requirements for Air Filtration Section:
      1) Comply with NFPA 90A.
      2) Minimum Arrestance: According to ASHRAE 52.1 and a MERV according to ASHRAE 52.2.
      3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

b. Disposable Panel Filters:
   1) Factory-fabricated, viscous-coated, flat-panel type.
   2) Thickness: 1 inch.
   3) Arrestance according to ASHRAE 52.1: 80.
   4) Merv according to ASHRAE 52.2: 5.
   5) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
   6) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.4 OUTDOOR UNITS (5 TONS OR LESS)
   A. Air-Cooled, Compressor-Condenser Components:
      1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
      2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
         a. Compressor Type: Scroll.
         b. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.
      3. Fan: Aluminum-propeller type, directly connected to motor.
      5. Low Ambient Kit: Permits operation down to 10 deg F.

2.5 OUTDOOR UNITS (6 TONS OR MORE)
   A. Air-Cooled, Compressor-Condenser Components:
      1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

   a. Compressor Type: Scroll.
   b. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.

3. Fan: Aluminum-propeller type, directly connected to motor.
5. Low Ambient Kit: Permits operation down to 10 deg F.

2.6 ACCESSORIES

   A. Control equipment and sequence of operation are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."

   B. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

PART 3 - EXECUTION

3.1 INSTALLATION

   A. Install units level and plumb.

   B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

   C. Install ground-mounted, compressor-condenser components on 4-inch-thick, reinforced concrete base that is 4 inches larger, on each side, than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

   D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

   A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

   B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

   A. Perform tests and inspections.

   B. Tests and Inspections:
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

END OF SECTION 23 81 26
SECTION 23 82 19 - FAN COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary
   Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes fan-coil units and accessories.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and
   accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads,
   required clearances, method of field assembly, components, and location and size of each field
   connection.


1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and
   maintenance manuals. In addition to items specified in Division 01 Section "Operation and
   Maintenance Data," include the following:

1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70,
   Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for
   intended use.

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6
   - "Heating, Ventilating, and Air-Conditioning."

1.7 COORDINATION

Henderson - Biobehavioral Health Building
DGS 800-290/PSU 06-42744/BCJ 08001  12 November 2010
A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In the Fan-Coil-Unit Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 FAN-COIL UNITS

A. Available Manufacturers:

1. Carrier Corporation.
2. Engineered Air Ltd.
3. Trane.
4. YORK International Corporation.

B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.

C. Coil Section Insulation: 1/2-inch thick minimum, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

D. Main and Auxiliary Drain Pans: Plastic. Fabricate pans and drain connections to comply with ASHRAE 62.1. Drain pans shall be removable.

E. Chassis: Galvanized steel where exposed to moisture. Floor-mounting units shall have leveling screws.

F. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.

1. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with integral stamped discharge grilles.
2. Steel recessing flanges for recessing fan-coil units into ceiling or wall.

G. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.
H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

I. Fan and Motor Board: Removable.
   1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
   2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   3. Wiring Termination: Connect motor to chassis wiring with plug connection.

J. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls" and

K. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.
   B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
   A. Install fan-coil units level and plumb.
   B. Install fan-coil units to comply with NFPA 90A.
   C. Suspend fan-coil units from structure with elastomeric hangers. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
   D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation.
   E. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS
   A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 82 19
SECTION 23 82 33 - CONVECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following:
   2. Flat-pipe steel radiators.

1.3 ACTION SUBMITTALS
A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Plans, elevations, sections, and details.
   2. Details of custom-fabricated enclosures indicating dimensions.
   3. Location and size of each field connection.
   4. Location and arrangement of piping valves and specialties.
   5. Enclosure joints, corner pieces, access doors, and other accessories.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Structural members, including wall construction, to which convection units will be attached.
   2. Method of attaching convection units to building structure.
   3. Penetrations of fire-rated wall and floor assemblies.
B. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For convection heating units to include in emergency, operation, and maintenance manuals.
1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 HOT-WATER OR STEAM FINNED-TUBE RADIATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Embassy Industries, Inc.
2. Engineered Air.
3. Rittling, a div. of Hydro-Air Components.
4. Rosemex.
5. Slant/Fin.
6. Trane.

B. Performance Ratings: Rate finned-tube radiators according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."

C. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports. One tube end shall be belled.

D. Element Supports: Ball-bearing cradle type to permit longitudinal movement.

E. Support Brackets: Locate at maximum 36-inch spacing to support element.

2.2 FLAT-PIPE STEEL RADIATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Runtal North America, Inc.

B. Heating Elements: Steel, welded and formed into flat, square, steel header with minimum thickness of 0.109 inches. Include threaded piping and air vent connections.

1. Working Pressure 56 psig : 0.048 inch .

C. Mounting: Wall brackets or floor pedestals as indicated on plans on maximum spacing of 36 inches .

D. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas to receive convection heating units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for hydronic-piping connections to verify actual locations before convection heating unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FINNED-TUBE RADIATOR INSTALLATION

A. Install units level and plumb.

B. Install finned-tube radiators according to Guide 2000 - Residential Hydronic Heating.

C. Install valves in accessible location above ceiling.

3.3 FLAT-PIPE STEEL RADIATOR INSTALLATION

A. Install units level and plumb.

3.4 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot-water units and components to piping according to Division 23 Section "Hydronic Piping."

   1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.

C. Install control valves as required by Division 23 Section "Instrumentation and Control for HVAC."

D. Install piping adjacent to convection heating units to allow service and maintenance.

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace convection heating units that do not pass tests and inspections and retest as specified above.

END OF SECTION 23 82 33
SECTION 23 82 39 - UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Cabinet unit heaters with centrifugal fans and hot-water coils.
   2. Propeller unit heaters with hot-water coils.

1.3 ACTION SUBMITTALS
A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Plans, elevations, sections, and details.
   2. Location and size of each field connection.
   3. Details of anchorages and attachments to structure and to supported equipment.
   4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
   5. Location and arrangement of piping valves and specialties.

1.4 INFORMATIONAL SUBMITTALS
A. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Berko Electric Heating; a division of Marley Engineered Products.
2. Carrier Corporation.
3. Engineered Air Ltd.
4. Indeeco.
5. Markel Products; a division of TPI Corporation.
7. McQuay International.
8. QMark Electric Heating; a division of Marley Engineered Products.
9. Trane.
10. USA Coil & Air.

B. Description: A factory-assembled and tested unit complying with ARI 440.

C. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.

1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch thick, galvanized, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Recessing Flanges: Steel, finished to match cabinet.
3. Control Access Door: Key operated.
4. Base: Minimum 0.0528-inch thick steel, finished to match cabinet, 4 inches min high with leveling bolts.

D. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated: 90 percent arrestance and 7 MERV.

E. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

F. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

G. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."
H. Electrical Connection: Factory wire motors and controls for a single field connection.

2.2 PROPELLER UNIT HEATERS
A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Engineered Air Ltd.
   3. Trane.
B. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.
C. Cabinet: Removable panels for maintenance access to controls.
D. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.
E. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.
F. General Coil Requirements: Test and rate hot-water propeller unit heater coils according to ASHRAE 33.
G. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.
H. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
I. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Motor Type: Permanently lubricated.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Examine roughing-in for piping and electrical connections to verify actual locations before unit heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cabinet unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.

C. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Suspend propeller unit heaters from structure with all-thread hanger rods and. Hanger rods and attachments to structure are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Comply with safety requirements in UL 1995.

E. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."

F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 82 39
PART 1  GENERAL

1.1  RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of the Contract, General Conduct of the Work and Special Requirements, and Division 1 Specification Sections, apply to this Section.

1.2  OVERVIEW

A. This document contains the specification and input/output summaries for the Building Automation System (BAS) for the Henderson Bridge Replacement Building, PSU #06-42744 / BCJ 08001 at University Park campus. The system architecture shall utilize intelligent distributed control modules, located at each site, which communicate over a local controller network. The BAS shall provide Direct Digital Control (DDC), monitored and adjusted by the University’s Automated Logic WebCTRL or JCI Metasys System Extended Architecture software at University Park, both via Microsoft Internet-Explorer, the thin-client user interface. This BAS for the air conditioning, heating and ventilating systems shall interface with other microprocessor based building subsystems as shown on the drawings and as specified.

B. Contractor Alert: Many aspects of the installation and implementation of this project require approval by the University’s Physical Plant BAS Group before the BAS installation shall proceed.

1.3  RELATED SECTIONS

A. Specifications where Equipment is purchased by Others, that will have BAS controllers provided by CSC to be installed at the factory (factory-installed Controls, i.e. VAV boxes, etc.)

1. Section 23 36 00 - Air Terminal Units

B. 3rd-Party Interfacing is required on this project according to the following Specification sections for sub-systems. Figure 1 (ALC) or Figure 2 (JCI), depending on which is the selected BAS, shall be provided to the Vendor that provides the following Equipment on this Project, so Vendor understands how the communications-networking needs to function:

1. Section 23 0514 – Variable Frequency Motor Controllers for HVAC Equipment

2. Section 26 0943 – Network Lighting controls

1.4  REFERENCES


1.5  DEFINITIONS

A. BAS refers to the Building Automation System. (In the past, this may have been referred to as CCS, Central Control System, EMS, Energy Management System, or ATC, Automatic Temperature Control.)

B. Critical Space refers to a space that is being backed-up by redundant utilities and/or redundant HVAC system(s) (i.e. Animal Rooms, Temperature-critical research, etc.).

C. CSC refers to the Control System Contractor. The CSC is the Contractor responsible for the implementation of this Section of the Specifications.

D. Enhanced Zone Sensor refers to a Room Sensor with Set-point Adjustment and Occupancy Override.

E. Gateway refers to the interface (hardware and/or software) to provide seamless integration
by non-BAS equipment manufacturers. Refer to paragraph 2A.2 “BAS Interfacing with 3rd-Party Sub-systems”.

F. I/O refers to Input/Output. Thus, "I/O device" means "Input/Output device".

G. IP refers to the Internet Protocol.

H. Night Lighting refers to non-emergency exterior lights mounted to the building.

I. OEM stands for Original Equipment Manufacturer, and refers to the manufacturer of the equipment being provided that includes a microprocessor based building sub-system [VFD(s), Lighting Controls, and/or Electrical Monitoring] for this Project.

J. Object Table(s) refer(s) to the detailed listing(s) of BACnet objects and the functional requirements using the various operator interfaces for the system. In the past, this/these may have been referred to as "Points List(s)" and "I/O Summary".

K. On-line refers to accessibility via the thin-client user interface.

L. Primary Equipment refers to Heating, Cooling and/or Air Moving SOURCE equipment. This includes HW System (pumps, HX, valves, sensors, etc.), CHW System (pumps, valves, sensors, etc.), ACFs, etc. This does NOT include Terminal Equipment (see separate definition).

M. Terminal Equipment refers to Heating, Cooling and/or Air Moving equipment connected to Primary Equipment and directly serving a Conditioned Zone in the Building. This includes FCUs, CUHs, VAVs, FTR, etc. This definition is separate from Primary Equipment (see separate definition).

N. Thin-client User Interface refers to the software program Microsoft Internet Explorer.

O. TNS refers to Penn State’s Telecommunications and Networking Services at The Pennsylvania State University.

P. OWS refers to an Operator Work Station, also seen as Operator Workstation.

Q. “University’s Physical Plant BAS Group” refers to University employees designated by the Office of Physical Plant (OPP) Energy & Engineering Division.

1.6 MANUFACTURER

A. Automated Logic Corporation (ALC), as installed by ALC Pittsburgh branch office.

B. Johnson Controls Inc. (JCI) (Metasys System Extended Architecture), as installed by Harrisburg branch office.

C. No other Manufacturers are allowed.

1.7 SCOPE OF WORK

A. This specification is using the JUL2010 version of the PSU BAS Guide Specification. Some of the revisions since the JAN2008 version will affect the Scope of Work. The CSC must carefully review this entire Specification Section 25 55 00 as the Design Professional may also have new and added requirements.

B. Control System Contractor’s (CSC) Responsibilities:

1. The CSC shall furnish and install all necessary hardware, wiring, computing equipment and software required to provide a complete and functional system necessary to perform the design intent given in the sequences of operation, and as defined in this specification.

2. The CSC is fully responsible for coordinating the work required of the OEM when there is a 3rd-party sub-system provided in the project.

3. All costs associated with the work of this Section shall be included in the CSC’s contract.

4. The CSC shall coordinate the CSC’s work with other trades.

C. System Requirements
1. All material and equipment used shall be standard components, regularly manufactured and available, and not custom designed especially for this project. All systems and components, except site specific software, shall have previously been thoroughly tested and proven in actual use prior to installation on this project.

2. The system architecture shall be fully modular permitting expansion of application software, system peripherals, and field hardware.

3. The system, upon completion of the installation and prior to acceptance of the project, shall perform all operating functions as detailed in this specification.

D. Equipment

1. System Hardware
   a. The CSC shall provide the following:
      (1) Operator workstation(s) and control modules.
      (2) All relays, switches, sensing devices, indicating devices, and transducers required to perform the functions listed in Object Table(s).
      (3) All monitoring and control wiring.
      (4) For this project, the CSC shall connect to (physical wiring and/or via programming) the integration gateway modules and software to interface with the following third party equipment:
         (a) Variable Frequency Motor Controllers for HVAC Equipment
         (b) Modular Indoor Central-Station Air-Handling Units
         (c) Network Lighting controls

2. System Software
   a. The CSC shall provide all software identified in this specification. The database required for implementation of these specifications shall be provided by the CSC, including point descriptor, alarm limits, calibration variables, on-line graphics, reports and point summaries. The CSC shall provide and create the system using the latest software release, at the time of Shop Drawing approval.
   b. Site-license: For this project, at least one (1) additional software license for the existing campus Automated Logic WebCTRL or JCI Metasys System Extended Architecture software shall be provided.

E. Object Table(s)

1. The system as specified shall monitor, control, and calculate all of the points/objects and perform all the functions as listed in sequences of operation and as shown in control diagrams in this specification and in the contract drawings.

2. All objects, including Application Controller level objects, shall be exposed as BACnet Objects.

F. Codes and Regulations

1. All electrical equipment and material and its installation (including programming) shall conform to the current requirements of the following authorities:
   a. Occupational Safety and Health Act (OSHA)
   b. National Electric Code (NEC), 2005
   c. International Fire Code, 2006
d. International Mechanical Code, 2006


g. International Building Code, 2006

h. International Existing Building Code, 2006

i. International Plumbing Code, 2006

2. All distributed, application controllers supplied shall be in compliance with the following listings and standards:
   a. UL916 for Open Energy Management
   b. CE Electro Magnetic Compatibility

3. The control system manufacturer shall have quality control procedures for design and manufacture of environmental control systems for precise control and comfort, indoor air quality, HVAC plant operation, energy savings and preventative maintenance.

4. Where two or more codes conflict, the most restrictive shall apply. Nothing in this specification or related documentation shall be construed to permit work not conforming to applicable codes.

G. Building Ethernet Connection Cabling: The building Ethernet shall be provided by the University (cooperation between Physical Plant and TNS), at the Building Telecommunications closet(s), and a Network Switch is provided and installed by Physical Plant personnel at this location. The CSC shall provide CAT-5e or CAT-6 cabling between Global Building Controller(s)/Router(s) and the Building Telecommunications Closet(s). The CSC shall provide repeaters between Global Building Controllers /Routers and the Building Ethernet Connection as required. Final Building Ethernet Connection terminations shall be by the CSC and shall be coordinated with the University's Physical Plant BAS Group.

H. Major Systems Cabling: The CSC shall provide CAT-5e or CAT-6 cabling between the Global Building Controller location and each location of an Air Handler, Heating System, and/or Chilled Water System Panel. All terminations shall be completed by the CSC.

I. The CSC shall provide all object mapping and programming and shall coordinate object naming conventions and network map requirements with the University's Physical Plant BAS Group. The naming convention shall be submitted with the BAS Shop Drawings for review and approval by the University's Physical Plant BAS Group.

J. The CSC shall provide a circuit from an existing Normal/Emergency power panel and an UPS for the Global Building Controller/Routers and, if necessary, for repeaters and Application Controllers serving emergency and/or critical equipment.

K. The CSC shall provide router and software to route BACnet messages over the existing Campus Ethernet infrastructure using BACnet standard Annex J routing (BACnet over IP). Existing Campus Ethernet infrastructure has multiple subnets and is capable of routing IP messages.

L. Refer to Figure 1 and Figure 2 at the end of this Section for a graphical indication of the Scope of Work, as it relates to the campus infrastructure and OEM equipment.

1.8 SUBMITTALS

A. Submit under provisions of Division 1.

B. BAS Intent Meetings:
   1. Purpose of BAS Intent Meetings: The GOAL of these Meetings is to be proactive about having the Controls Design, including the Programming Logic, to be consistent with the INTENT of the Systems (a "system" involves Equipment and
Sequence of Operation). The Design Intent is best understood by the Design Engineer, and the PSU Engineering Services Engineer responsible for Reviewing and guiding the Project. Text language can often be interpreted in different ways. By having face-to-face discussions, miss-interpretations should be able to be avoided early in the Construction-process.

2. Form of Meetings:
   a. There shall be at least two (2) Meetings, but not less than the number of Meetings that are required to adequately cover the BAS Intent. This will depend on the size of this Project.
   b. Meeting Details:
      (1) The first BAS Intent Meeting shall be conducted by the Owner, and shall be held prior to the CSC starting the BAS Shop Drawings Submittal. Contact the PSU Project Manager with at least 10-days advance notice for scheduling this Meeting.
      (2) The second (and additional) BAS Intent Meeting(s) shall be conducted by the CSC, when the BAS Shop Drawings Submittal is approximately 50% completed, to verify that everything is “on-track” according to the BAS Intent (defined by Designer & Owner).

3. Meeting Attendance:
   a. Required:
      (1) The Project’s Mechanical Design Engineer (the person responsible for, and knowledgeable-about, the Sequences of Operation)
      (2) PSU Engineering Services Engineer (at least Mechanical, and possibly also Electrical)
      (3) PSU BAS Group representative
      (4) Applications Engineer for the CSC (Control System Contractor)
      (5) Project Manager for the CSC
   b. Possible:
      (1) the Project’s CM (Construction Manager) representative
      (2) Programmer /Logic-developer for the CSC
      (3) the Project’s Cx-provider
      (4) PSU Cx Services representative
      (5) PSU Project Management representative

4. BAS Shop Drawings Submittal, presented at the 50% completed stage, shall include at a minimum:
   a. Cover Sheet /Title Sheet, Index, Legend and Letter of Factory Training Credits.
   b. Communications Riser (complete for the entire Project), and Device Addressing Scheme
   c. System Schematic, 1 for each System
   d. Sequence of Operation, 1 for each System
   e. Valve and Damper Schedules
   f. Product Data Sheets: This shall include at least a LIST of the Controllers and Devices to be used. The “list” could be a “combined BOM”, and then submit Product Data Sheets for just the new or not-common Devices.
BAS Shop Drawings Submittal (for Approval) will still include Product Data Sheets for ALL the Materials on the Project, as these are important for future reference.

C. As soon as Submittals are prepared, an electronic version shall be provided simultaneously with the mailing of the paper copies to the Project Contractor-chain. The electronic version shall be transmitted via e-mail, to expedite the approval process. Provide Submittal in electronic format to: Bob Mulhollem, Manager of Environmental Systems, REM26@psu.edu, 863-7220.

D. Air Flow Monitoring Station (AFMS) Product Data Sheets
   1. Submit product data sheets and technical Installation, Operation and Maintenance Manual for thermal dispersion airflow measuring devices indicating minimum placement requirements, sensor density, sensor distribution, and installed accuracy to the host control system.

E. BAS Shop Drawings: The Building Number and PSU Project Reference Number shall be part of each piece of the Shop Drawings Submittal. All controls drawings shall be B-size (11” x 17” sheet), C-size (24” x 18” sheet ) or D-size (36” x 24” sheet), and shall be completed and provided using Visio, or AutoCAD. A minimum of four (4) copies of shop drawings shall be submitted and shall consist of the following:
   1. Shop Drawings shall include:
      a. Cover Sheet /Title Sheet: Attached to the Front of all Submittal Sheets, this shall include a minimum of: Project Name; Project Location; Project Number, Building Number; CSC Contractor Name, Address, Phone Number(s); Project Engineer Name; Mechanical Contractor Name; Submission Date; Date and Name of the Project Construction Documents used to create the Submittal. When resubmitted for Record Documentation, the Date of As-Builts shall be added.
      b. Index: The first sheet of the Shop Drawings shall be an Index of all sheets in the set.
      c. Legend: A description of symbols and acronyms used shall be provided at the beginning of the set of Shop Drawings.
      d. Letter of Factory Training Credits, per requirements in Part 3 – Training.
      e. Communications Riser: A single-page diagram depicting the system architecture complete with a communications riser. Riser shall include room locations and addressing for each controller. Include a Bill of Material for all equipment in this diagram but not included with the unique controlled systems. Renovations and/or expansions to an existing BAS shall be developed using the existing communications riser diagram available from the University’s Physical Plant BAS Group.
      f. Device Addressing Scheme: Install controllers implementing an addressing scheme consistent with the Reference-document "Device Instance at Penn State". The document "Device Instance at Penn State.doc" is available on the PSU Design Standards website. The addressing scheme shall be submitted, reviewed and approved by the University’s Physical Plant BAS Group prior to implementation.
      g. Equipment Numbering: Acronyms used for equipment installed for this project shall follow the "Equipment Identifier Prefix Acronym" listing prepared by the University’s Office of Physical Plant and available on the PSU Design Standards website. The numbering assigned to equipment installed for this project shall sequentially follow the numbering of existing equipment of the same type in the same building. The equipment numbering scheme shall be submitted, reviewed and approved by the University’s Physical Plant BAS Group prior to implementation.
h. Systems Summary: Drawings shall include a table listing each piece of equipment and the area(s) served by each piece of equipment.

i. Valve Schedule: The Valve Schedule(s) shall be submitted using the Template provided by PSU, and shall be reviewed and approved by the Professional prior to installation of any Valve. The document "Valve Schedule_Template.xls" is available on the PSU Design Standards website.

j. Damper Schedule: The Damper Schedule(s) shall be reviewed and approved by the Professional prior to installation of any Damper.

k. Object Table: Object Table shall include all I/O points, all Alarm points and all Trend points. Information on each point shall include the following:
   (1) Point type
   (2) Point description
   (3) Point name
   (4) Alarm limits, if applicable
   (5) Whether or not a Trend is Enabled on point
   (6) What Trend is triggered on, if applicable
   (7) Whether or not Trend historian (archive) is enabled on point
   (8) Event Category and Event Template assigned to point

l. Floor Plans: Drawings shall include the proposed location of all field devices and the routing of the communications cabling.

m. System Schematic: Drawings shall include a single-line representation of the equipment being controlled, including all field devices required for properly controlling equipment and implementing the sequences of operation for this project.

n. Sequence of Operation: Drawings shall include Sequences of Operation for each piece of equipment with a unique configuration. The sequences shall be written in English text in such a way as to clearly convey how the design sequence of operation has been implemented by the controls design included in this Submittal. The design sequence of operation is that which is provided in the specification and in the contract drawings for this project as provided by the Professional. A simple duplication of the design sequence of operation provided in the specification for this project and in the contract drawings is not acceptable. The Sequences of Operation shall follow the outline below for a pattern of form and content. Each device that is referred to shall have the Device Tag identified in parentheses.

   (1) TITLE
   (2) GENERAL (include Set Points, Schedule, etc.)
   (3) MODES OF OPERATION
      (a) Unoccupied
         (1) Heating
         (2) Cooling
      (b) Occupied
         (1) Heating
         (2) Cooling
   (3) INTERLOCKS (i.e. Fume Hoods, Exhaust Fans, etc.)
(4) SAFETIES (i.e. Freeze Protection, Smoke Detector, etc.)

o. Point-to-point Wiring Details: Drawings shall include point-to-point wiring
details and must show all field devices, start-stop arrangement for each
piece of equipment, equipment interlocks, controllers, panel devices, wiring
terminal numbers and any special information (i.e. shielding requirements)
for properly controlling equipment and implementing the required sequences
of operation.

p. Bill of Material: Drawings shall include a bill of the material necessary and
used for properly controlling equipment and implementing the required
sequences of operation. As-built documents shall include the Valves and
Dampers installed.

q. Configuration Details: Drawings shall include programming and parameter
setup information necessary for each controller used to properly control
equipment and implement the required sequence of operation.

r. On-line Graphics: Submit a sample of a typical graphical representation of
the equipment, logic and communication riser. The sample can be from a
previous project that had the same equipment.

s. Each unique controlled system or piece of equipment shall include the
following items (described above):

(1) System Schematic
(2) Sequence of Operation
(3) Point-to-point Wiring Details
(4) Bill of Material
(5) Configuration Details
(6) On-line Graphic (sample)

t. Controller Table: A complete table for each and every controller installed per
this project, shall be included in the BAS Shop Drawings Submittal, and a
separate electronic copy of the table in “Microsoft Excel” format, shall be
provided (via email, to Bob Mulhollem). Contact the University’s Physical
Plant BAS Group for an example or template. This table shall include the
following:

(1) The University Campus location where the equipment and controller will
be installed
(2) The official University building inventory number where the equipment
and controller will be installed
(3) The building name where the equipment and controller will be installed
(4) The BACnet device instance of the controller.
(5) The BACnet network instance that the controller shall reside on.
(6) The UDP port that is being utilized by any device on the BACnet/IP
network
(7) The manufacturer’s name of the controller
(8) The manufacturer’s model number of the controller
(9) The network media type that the controller resides on

2. BAS shop drawings shall be submitted to and approved by the University’s Physical
Plant BAS Group before any aspect of the BAS installation shall proceed.
Therefore, shop drawings must be submitted in time for the Professional and the
University’s Physical Plant BAS Group review so that all installations can be
completed per the project’s completion schedule. Ten working days shall be
allowed for the Professional and the University’s Physical Plant BAS Group to
review submittals.
3. As-Built Drawings shall be created after the final system checkout, by modifying and adding to the Shop Drawings. As-Built Drawings shall show exact installation. As-Built Drawings will be acknowledged in writing by the Professional and the University’s Physical Plant BAS Group after the final checkout of the system. The system will not be considered complete until the As-Built Drawings have received their final approval. The CSC shall deliver four sets of As-Built Drawings to the University’s Physical Plant BAS Group, with copy of the transmittal to the University’s Project Management. Equipment Panel As-Built Drawings shall be provided prior to acceptance of the completed BAS installation.

4. In addition to the Controller Table listed above, and before final configuration, the CSC shall provide Object Table(s) form(s) to the Professional and the University’s Physical Plant BAS Group that include:
   a. Description of all points/objects.
   b. Listing of binary and analog hardware required to interface to the equipment for each function.
   c. Listing of all application programs associated with each piece of equipment.
   d. BACnet device and object instances.
   e. Event Parameters.
   f. Failure modes for control functions to be performed in case of failure.

F. Construction Schedule of CSC’s milestones:

1. The CSC shall submit to the University’s Project Management a detailed schedule, identifying all activities from the contract award to system warranty expiration. The schedule shall be coordinated with all other Contractors and shall be submitted within 90 days after the notice to proceed. The schedule shall include, but shall not be limited to, the following milestones:
   a. notice to proceed;
   b. submittal of this detailed-schedule
   c. date for the first BAS Intent Meeting, to be scheduled (by PSU, the Owner) prior to the CSC starting the BAS Shop Drawings Submittal (if the date for this Meeting occurs before the detailed-schedule is submitted, then date of notification to the PSU Project Manager should also be included);
   d. distribute the 50% completed BAS Shop Drawings Submittal for review and comment by the Design Engineer and the University’s Engineering Services Engineer;
   e. the second BAS Intent Meeting, conducted by the CSC when the BAS Shop Drawings Submittal is approximately 50% completed (additional Meetings, as necessary, can be included but are not required to be included);
   f. submit BAS Shop Drawings Submittal, and associated hardware and software documentation, for review and approval by the University’s Physical Plant BAS Group;
   g. receive work approval; Notice: No portion of the field installation may begin without the Physical Plant BAS Group’s approval of working drawings, and hardware, firmware and software documentation, unless specific written instructions to the contrary are provided by the University’s Physical Plant BAS Group.
   h. begin field installation;
   i. complete installation of all thermowells;
   j. complete installation of wiring runs;
k. complete installation of remote field devices;
l. deliver major BAS components and operator interface / telecommunications equipment;
m. complete installation of panels, communication equipment, processors, etc.;
n. complete installation of operator interface and telecommunications equipment;
o. complete identification of all BAS equipment;
p. complete initial applications engineering and provide the University’s Physical Plant BAS Group with programming and database for review;
q. revise programming input variables, as required;
r. submit copy of construction mark-up set for review and use in commissioning;
s. commission system, using the initial set of online graphics (systems and dynamic thermo-graphic floorplans);
t. notify the University’s Project Management and Physical Plant BAS Group, in writing, of system completion and preparations for acceptance testing;
u. schedule acceptance testing to permit a member of the University’s Physical Plant BAS Group to be present;
v. provide assistance to Cx-provider, as-necessary per Project Scope;
w. complete punch list items;
x. complete training, using construction mark-up set of BAS Shop Drawings;
y. submit approved as-built drawings, and complete revisions to the initial set of online graphics;
z. initiate warranty period;
aa. terminate warranty period.

2. The CSC shall submit similarly detailed schedule information, revised if necessary, for any additional work which will extend the effectiveness of the BAS and is contracted either concurrent to or immediately following the term of the present installation. It shall be the responsibility of the CSC to alert the University’s Project Management of any scheduling conflicts, and to defer to the judgment of the University in the resolution of those conflicts.

3. The CSC shall provide additional workers and/or overtime hours as deemed necessary by the University to meet scheduled completion dates.

4. Should the CSC fail to maintain any part of the installation schedule, the University reserves the right to require written weekly progress reports. If the University so elects, the CSC shall provide a then-current schedule and shall provide written updates to that schedule to both the University and the Professional on a weekly basis. If this option is exercised by the University, the schedule shall be delivered to the University and the Professional no later than the Thursday immediately preceding the week during which the schedule will become effective. Bidders will note that it remains the intent of the University to execute all available remedies under this contract to ensure the CSC’s best efforts to satisfy the initial milestone scheduling. All programming tools shall be provided as part of the system. CSC shall provide any system upgrades released during the warranty period free of charge to the University.

G. Operating and Maintenance Manuals
1. Operating and Maintenance (O&M) manuals for the system shall include the following categories: Workstation User's Manual and Project Engineering Handbook, and Software Documentation. Project specific manuals shall include detailed information describing the specific installation.
   a. Workstation User's Manual shall contain as a minimum:
      (1) System overview.
      (2) Networking architecture.
      (3) The object tables.
      (4) The sequences of operation.
      (5) The graphical programming.
      (6) Established setpoints and schedules.
      (7) Summary of trend objects.
      (8) User manuals for the ‘third party’ software
   b. Project Engineering Manual shall contain as a minimum:
      (1) System architecture overview
      (2) Hardware cut-sheets and product descriptions
      (3) Wiring diagrams for all controllers and field hardware
      (4) Installation, mounting and connection details for all field hardware and accessories
      (5) Commissioning and setup parameters for all field hardware
      (6) Maintenance procedures, including final tuning and calibration parameters.
      (7) Spare parts list.
      (8) Record Software Documentation shall contain as a minimum:
         (a) Graphical programming must be represented using either Visio or AutoCAD.
         (b) Graphical representation of all control logic for every piece of mechanical equipment controlled on the project, together with a glossary or icon symbol library detailing the function of each graphical icon. ‘Line by line’ computer program documentation is unacceptable.
         (c) Detailed description of control sequences used to achieve the specified sequences.

H. PICS: Provide a BACnet Protocol Implementation Conformance Statement (PICS) for each system element proposed (Operator workstation, LAN Gateway/Controller, Logic Controller, Routers, Repeaters, Converters, Application Controllers). This PICS shall contain all of the information described in Section 22.1.1.1, and shall be in the format found in Annex A, of ASHRAE Standard 135.

I. Provide complete description and documentation of any proprietary services and/or objects.

1.9 COORDINATION WITH OTHER CONTRACTORS

A. When the Project involves removal and/or demolition of existing BAS Panel(s) and/or BAS cables (wire or fiber):

   1. Contact the Project Manager and BAS Group to coordinate the disconnection of the equipment from the active CCS network, and
2. All wiring and tubing abandoned by the work of the CSC, during the course of completing this Project, shall be removed in total. Abandoned Controllers, Panels and Devices shall be retained by, and as determined by, PSU Physical Plant Area Services.

3. Contact the Project Manager and the Area Services Supervisor to coordinate the placement of removed equipment into an inventory of Spare Parts for the Building being renovated or demolished.

B. Review the installation of all controlled systems such as air handling equipment, duct work, piping, pumps, fans, and similar equipment for the purpose of providing the appropriate installing contractor correct information for wells, relays, panels, access panels, and similar appurtenances required for the control system. Such information shall include physical size, proper location and orientation, and accessibility requirements.

C. The CSC shall coordinate the installation of all control devices, and shall ensure that supporting work by others such as installation of thermometer wells, pressure taps, orifice plates and flanges, access panels, electronic transducers, and other items required are included. The CSC shall schedule and coordinate the work to ensure that the items are installed in the proper manner at the appropriate time.

D. Coordinate the Pressure and Temperature test plugs (P/T ports) that are required adjacent to all electronic pressure and temperature BAS sensors in hydronic systems (for testing/calibration purposes). Installed per Section 23 05 19.

1.10 CONTRACTOR (CSC) EXPERIENCE AND PERFORMANCE

A. The University requires a BAS that is installed, programmed, commissioned, and serviced by an experienced CSC. To insure the University of proper BAS service and support, the CSC shall be the authorized distributor of the BAS manufacturer for the local area and if requested by the University shall supply proof thereof. In view of this, the CSC shall have installed a minimum of five BASs of the same type and size as the BAS herein specified and shall provide job names, a brief description of the scope of each BAS job, and a point of contact for each job. The actual, local CSC or BAS branch office, rather than the BAS manufacturer, will provide this information.

B. The CSC shall have a local office or representative within the state of Pennsylvania, staffed with factory trained engineers, fully capable of providing instruction, routine maintenance, and emergency maintenance service on all system components. The CSC shall be responsible for replacement of: the controllers with current job software, printer, PC(s), sensors, and devices at all times for a period of not less than 1 year following project completion, and shall guarantee replacement and software reprogramming of a system in need of repair, within a 24 hour period after notification from the University. In the case of an after-hours emergency, the CSC shall provide after-hours emergency services which will, upon notification of an emergency situation, result in CSC personnel being on-site within four hours if necessary.

C. The CSC must have an acceptable performance record with the University. The performance record of the CSC will be subject to an annual review by the University’s Physical Plant BAS Group.

1.11 WARRANTY & SERVICE

A. Provide warranty under provisions of Division 1.

B. Provide all services, materials and equipment necessary for the successful operation of this system for a period of one year. Provide all recommended preventive maintenance which is indicated in the O&M Manuals during this period. In addition, provide two (2) semi-annual visits for testing and evaluating the performance of the networked equipment installed per this specification. One visit shall be during the cooling season and one visit shall be during the heating season. Provide a written report after each visit is complete. Coordinate service visits through the University’s Physical Plant BAS Group. This service visit shall
include, but not be limited to, the following:

1. Check calibration and re-calibrate if needed instrumentation sensors for air flow, liquid flow, pressure, humidity, temperature, and transducers. Written records shall be kept indicating the performance of such calibrations along with pertinent data.

2. Check the operation of dampers and damper actuators to assure no lock up has occurred and stroke is proper. Written records shall be kept indicating the performance of such calibrations along with pertinent data.

3. Check the overall system field operations by performing an all-points review (by hard copy or by documenting all-point inquiries). Verify that all monitoring and command points are valid and active.

4. Written records shall be kept indicating the performance of such exercises.

C. If a problem develops at any time during the warranty/service period, the CSC shall monitor and log the affected BAS point/object for the remainder of the warranty/service period. "A problem" in the above statement will refer to an incident in which any of the following occur:

1. An alarm occurs due to defective control system components or improper installation or programming.

2. Overall performance of the system is compromised due to defective control components or improper installation or programming.

3. Major recalibration (by greater than 5 times the catalogued accuracy) is required for a sensor during one of the service visits.

D. The CSC shall provide any system software upgrades released during the warranty period, free of charge to the University.

---- End of PART 1 --------------------------
PART 2A PRODUCTS, HARDWARE

2A.1 NETWORKING/COMMUNICATIONS

A. The design of the hardware and software shall network existing operator workstations at the PSU Campus with new Global Building Controllers /Routers provided under this Section. The network shall be implemented via the Campus shared Ethernet system. The campus shared Ethernet backbone uses IP communication protocol.

1. Ethernet Switch: For this project, the CSC shall provide an Ethernet switch in the same panel with the Global Building Controller /Router, to connect the Global Building Controller to the campus shared Ethernet backbone. This hardware shall be a 5-port 10/100 Mbps Ethernet-switch with DIN-rail mount; Contemporary Controls Model EISK5-100T or Equivalent.

B. All network parameters must be assigned and approved by the University’s Physical Plant BAS Group prior to implementation.

C. The system must be fully BACnet™ compliant at the time of installation. This means that the system must use BACnet™ as the native communication protocol between workstations or servers on the network.

D. The BACnet communication protocol is the required protocol for all tiers of the network.

2A.2 BAS INTERFACING WITH 3RD-PARTY SUB-SYSTEMS

A. General: The CSC shall be responsible for connecting all sub-systems to the BAS via native BACnet, or if not native BACnet, a sub-system shall be integrated via a gateway that converts the proprietary protocol to the BACnet protocol. Sub-systems include RTU(s), VFD(s), Chiller(s), Lighting Controls and/or Electrical Monitoring provided as part of this project (refer to Figure 1 and Figure 2 at the end of this specification section and related specification sections). These sub-systems shall be controlled, monitored and graphically programmed through the Graphical User Interface (GUI) software of the BAS.

B. Gateway: The gateway(s), required for the sub-system(s), shall be provided by the OEM. The gateway(s) is(are) further specified below:

1. The gateway Submittal shall be provided by the OEM to be included with the BAS Shop Drawings Submittal, for review and approval by the University’s Physical Plant BAS Group.

2. All system information specified in the sequence of operation and related documents shall be available to the BAS. Read and write capability, as indicated by an object table provided by the OEM, shall be provided to the mechanical and electrical equipment indicated and be available to the BAS system. The OEM shall provide to the CSC, a table of gateway objects and their functionality, including normal operating limits (i.e. High and Low Oil Temperature Limits from a Chiller control panel).

3. Define how the gateway interaction with equipment will comply with this section. OEMs shall bid a fully BACnet compliant device to facilitate interoperability between OEM electrical/mechanical sub-systems and the BACnet BAS or provide the necessary gateway to integrate into the web-based BACnet BAS (WebCTRL, or JCI Metasys System Extended Architecture) using the BACnet protocol.

   a. The OEM shall provide any software or hardware required to access or modify any electrical/mechanical subsystems (i.e. RTUs, VFD, Chillers, Lighting Controls and/or Electrical Monitoring).
b. Typical gateway requirements for projects include: A BACnet interface to the lighting controls manufacturer’s product(s), a BACnet interface to the VFD manufacturer’s product(s), a BACnet interface to the electrical monitoring manufacturer’s product(s) (Square D or Cutler-Hammer). A Modbus interface may be used only when a BACnet interface is not available.

4. If the equipment manufacturer does not have this capability, they shall contact the authorized representative of the CSC for assistance and shall include in their equipment price any necessary hardware and/or software obtained from the CSC to comply with this section.

C. OEM Configuration Tools and Licenses: Configuration Tools, and all software licenses, required to configure all OEM controllers installed on this project shall be provided.

2A.3 GLOBAL BUILDING CONTROLLER /ROUTER

A. Acceptable Products:
   1. ALC: LGR Ethernet Router
   2. JCI: NAE (Network Automation Engine)

B. GENERAL - Global Building Controller /Router
   1. The Global Building Controller /Router shall be a microprocessor based communications device. One of the functions of the Global Building Controller /Router is to provide a communications gateway between a controller network and an IP Ethernet network. The Global Building Controller /Router shall communicate via IP and be connected to the PSU campus Ethernet infrastructure. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification. Controller networks shall use the BACnet protocol.
   2. The Global Building Controller /Router shall support a network of at least 50 controllers.
   3. The Global Building Controller /Router shall provide a port which can be connected to Operator Workstations, portable computers, or modems.
   4. Global Building Controller /Router shall provide full arbitration between multiple users, whether they are communicating through the same or different Global Building Controller /Routers.
   5. The Global Building Controller /Router shall be responsible for routing global information from the various controller networks which may be installed throughout a building.

C. Memory: Each Global Building Controller /Router shall have sufficient memory to support its own operating system and databases including:
   1. Control processes
   2. Energy Management Applications
   3. Alarm Management
   4. Historical/Trend Data for 100% of all physical I/O for all programs in the Global Building Controller, at a minimum of 500 samples per Trend.
   5. Maintenance Support Applications
   6. Custom Processes
   7. Operator I/O

D. Expandability: The system shall be modular in nature, and shall permit easy expansion
through the addition of software applications, workstation hardware, application controllers, sensors, and actuators.

E. Integrated On-Line Diagnostics: Each Global Building Controller /Router shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The Global Building Controller /Router shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each Global Building Controller /Router, and shall not require the connection of an operator I/O device.

F. Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

G. Powerfail Restart: In the event of the loss of normal power, there shall be an orderly shutdown of all Global Building Controllers /Routers to prevent the loss of database or operating system software. Non-Volatile memory shall be incorporated for all critical Global Building Controller /Router configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

1. Upon restoration of normal power, the Global Building Controller /Router shall automatically resume full operation without manual intervention.

2. Should Global Building Controller /Router memory be lost for any reason, the user shall have the capability of reloading the Global Building Controller /Router via the Local Area Network (LAN).

H. Communications:

1. The controller network shall use BACnet™ as its native communication protocol. The communication between controllers shall be ARCNET or MS/TP at least 38.4 Kbps.

2. The Global Building Controller /Router shall utilize FLASH memory, battery backed RAM or firmware which shall allow for operating system updates to be performed remotely via TCP/IP or UDP/IP.

I. UPS: Uninterruptible Power Supply(s) is(are) required for the Global Building Controller(s), repeater(s) and/or Application Controllers that serve or monitor emergency and/or critical equipment.

2A.4 APPLICATION CONTROLLERS

A. Acceptable Products:


2. JCI: NCE, FEC-line of Controllers (BACnet), VMA Series 1600 (BACnet).

B. GENERAL - Application Controllers

1. Definition: An Application Controller, for this specification, could be an AAC (Advanced Application Controller) or an ASC (Application Specific Controller). These would be used on Primary Equipment and Terminal Equipment, respectively.

2. Application controllers must use BACnet™ as the native communication protocol between controllers.

3. Each Application Controller must be capable of standalone direct digital operation utilizing its own processor, non-volatile flash memory, input/output, minimum 8 bit A to D conversion, and include voltage transient and lightning protection devices. Firmware revisions to the module must be able to be made from the local workstation, portable operator terminals or from remote locations over modems or LANs.
4. The Application Controllers for Primary Equipment shall be expandable to the specified I/O point requirements. Each controller shall accommodate multiple I/O Expander Modules via a designated expansion I/O bus port. The controller, in conjunction with the expansion modules, shall act as one application controller.

5. All point data, algorithms and application software within the controllers shall be custom programmable from the Operator Workstation.

6. Each Application Controller shall execute application programs, calculations, and commands via a microcomputer resident in the controller. All operating parameters for application programs residing in each controller shall be stored in read/write-able nonvolatile flash memory within the controller and will be able to upload/download to/from the Operator Workstation.

7. Each Application Controller shall be configured on the workstation/server software as a BACnet™ device. All of the points shall be configured as BACnet objects. Each controller shall include self-test diagnostics which allow the controller to automatically relay to the Global Building Controller /Router any malfunctions or alarm conditions that exceed desired parameters as determined by programming input.

8. Each Application Controller should be capable of performing event notification (alarming).

9. Each Application Controller should be capable of scheduling using an on-board real-time clock.

10. Each Application Controller shall contain both software and firmware to perform full DDC PID control loops.

11. Each Application Controller shall contain a port for the interface of maintenance personnel's portable computer. All network interrogation shall be possible through this port.

12. If being installed outdoors, the Application Controllers shall be capable of being mounted directly in or on the equipment located outdoors. The Application Controllers shall be capable of proper operation in an ambient temperature environment of -20 degrees F to + 150 degrees F.

13. Input-Output Processing:
   a. Digital outputs shall be relays or triacs, 24VAC or VDC minimum. Each output shall be configurable as normally open or normally closed.
   b. Universal inputs shall be capable of 0-20mA, dry contact, and 0-5VDC or 0-10VDC.
   c. Analog output shall be electronic, voltage mode 0-10VDC or current mode 4-20mA.
   d. Enhanced Zone Sensor Input shall provide one thermistor input, one local setpoint adjustment, one timed local override switch, and an occupancy indicator.
   e. All programming sequences shall be stored in non-volatile memory. All programming tools shall be provided as part of the system. Provide documentation of all programming including configuration files.

14. Each Application Controller shall execute application programs, calculations, and commands via a microcomputer resident in the Application Controller. All operating parameters for application programs residing in each Application Controller shall be stored in read/write-able nonvolatile flash memory within the controller. Firmware revisions, application programs and program modifications to the controller shall be capable of being performed over the Wide Area Network (WAN).

15. Application Controller output circuits shall be optically isolated.
16. Each Application Controller shall be able to support various types of zone temperature sensors, such as temperature sensor only, temperature sensor with built-in local override switch, with setpoint adjustment switch.

17. Each Application Controller for VAV application shall have a built-in air flow transducer for accurate air flow measurement in order to provide the Pressure Independent VAV operation.

18. Each Application Controller for VAV applications shall have an integral direct coupled electronic actuator. The actuator shall provide on-off/floating point control with a minimum of 35 in-lb of torque. The assembly shall mount directly to the damper operating shaft with a universal V-Bolt clamp assembly. The actuator shall not require any limit switches, and shall be electronically protected against overload. When reaching the damper or actuator end position, the actuator shall automatically stop. The gears shall be manually disengaged with a button on the assembly cover. The position of the actuator shall be indicated by a visual pointer. The assembly shall have an anti-rotational strap.

19. Each Application Controller shall have LED indication for visual status of communication and power.

20. Astronomical Time: Astronomic capability shall allow the system to calculate sunrise and sunset times based on geographical location, and incorporate Daylight Savings Time, for dusk-to-dawn control or dusk-to-time control. This is required in any Application Controller with I/O for the Exterior lighting circuit(s).

21. In the event of a loss of communication, the Application Controller shall control from a standalone algorithm which maintains the assigned space temperature until communication is restored.

22. UPS: Uninterruptible Power Supply(s) is(are) required for any Application Controller that monitors or serves emergency and/or critical equipment.

23. All Application Controller level objects shall be exposed as BACnet Objects.

24. Primary Equipment shall be controlled using the same Application Controller, when possible.

25. Each Application Controller for Primary Equipment shall contain the following as Spare I/O:
   a. Minimum of: (3) Spare Universal Inputs (or 2-DIs and 1-AI), (1) Spare AO, and (2) Spare DOs.
   b. In addition to the Minimum, the Application Controller shall have 10% Spare I/O, of each type; UI (or DI and AI), AO and DO.

2A.5 LAPTOP COMPUTER(S)
   A. For this project, the CSC shall provide one Laptop Computer(s) to the University’s Physical Plant BAS Group prior to the start of the Acceptance Testing (reference subsection 3.11 - ACCEPTANCE OF COMPLETED BAS INSTALLATION).
   B. Provide a new laptop computer with the control system software and database as part of the project. Computer, in original packaging, is to be delivered to the University’s Physical Plant BAS Group via the Project Contractor-chain and the University’s Project Management.
   C. Provide an Allowance of $2000 per Laptop, at time of Bidding.
   D. At time of Purchase, contact PSU Physical Plant ITS group (865-7509 or mlf6@psu.edu) for the minimum specifications of the Laptop to be provided. Cost overruns or underruns shall be handled via Change-Order via the Project Contractor-chain and the University’s Project Management.

2A.6 FIELD HARDWARE/INSTRUMENTATION
A. Input Devices - General Requirements

1. Temperature sensors shall be of the type and have accuracy ratings as indicated and/or required for the application and shall permit accuracy rating of within 1% of the temperature range of their intended use.

2. Sensors used for mixed air application shall be the averaging type and have an accuracy of ± 1 degrees F.

3. Outside air temperature sensors shall have a minimum range of -52 degrees F to 152 degrees F and an accuracy of within ± 1 degrees F in this temperature range.

4. Room temperature sensors shall have an accuracy, of ± 1.0 degrees F in the range of 32 degrees F to 96 degrees F.

5. Chilled water sensors shall have an accuracy of ± 0.25 degrees F in their range of application.

6. Hot water temperature sensors shall have an accuracy of ± 0.75 degrees F over the range of their application.

7. Temperature-differential measurement shall use a matched set of sensors.

2A.7 SENSORS

A. AIR FLOW MEASUREMENT STATIONS (AFMS-x): See separate paragraph. These are considered more than just a "sensor".

B. Electronic Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

1. Thermistor temperature sensors as follows:
   a. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.
   b. Wire: Twisted, shielded-pair cable.
   c. Insertion Elements in Ducts: Single point, 18 inches (20 cm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (1 sq. m).
   d. Averaging Elements in Ducts: 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (1 sq. m); length as required.
   e. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
   f. Room Sensors: With Set-point Adjustment and Occupancy Override (Enhanced Zone Sensor), except when placed in Public Spaces. Sensors that must be installed on exterior walls shall include insulating bases. Refer to Part 3 for Execution requirements.
   g. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
   h. Room Temperature Security Sensors: Stainless-steel cover plate with insulated back and security screws.


   a. Accuracy: Plus or minus 0.2 percent at calibration point.
   b. Wire: Twisted, shielded-pair cable.
   c. Insertion Elements in Ducts: Single point, 18 inches (20 cm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (1 sq. m).
d. Averaging Elements in Ducts: Minimum 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (1 sq. m); length as required. Total length: 5 ft (1.5m) per 10 ft² (1 m²) of duct cross-section.

e. Mixed Air Temperature (MAT) shall be an averaging-type sensor, minimum 20ft length. For a Coil more than 20 ft², provide 1 ft (3 m) of sensing element for each 1 ft² (1 m²) of downstream face area of the mixing plenum.

f. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).

g. Room Sensors: With Set-point Adjustment and Occupancy Override, except when placed in Public Spaces. Sensors that must be installed on exterior walls shall include insulating bases.

h. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

i. Room Temperature Security Sensors: Stainless-steel cover plate with insulated back and security screws.


a. Accuracy: 5 percent full range with linear output.

b. Another standard span for room sensors below is 20 to 90 percent relative humidity with 2 percent accuracy.

c. Room Sensors: With cover matching room thermostats, span of 25 to 90 percent relative humidity.

d. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

4. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.

b. Output: 4 to 20 mA.

c. Building Static-Pressure Range: 0 to 0.25 inch wg (0 to 62 Pa).

d. Duct Static-Pressure Range: 0 to 5 inches wg (0 to 1243 Pa).

5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.

C. Equipment operation sensors as follows:

1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 inches wg (0 to 1243 Pa).

2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa).


D. Water-Flow Switches: Pressure-flow switches of bellows-actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless-steel or bronze paddle. For chilled-water applications, provide vaporproof type.

E. Carbon-Dioxide Sensor and Transmitter: Single detectors, using solid-state infrared sensors, suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55 deg C), calibrated for 0 to 2 percent, with continuous or averaged reading, 4 to 20 mA output, and wall or duct mounted.
F. Ceiling-mounted Room Sensor: When application requires this, these sensors shall be 10k Type2 Thermistor with 0-5vdc signal, by Veris Industries, http://www.veris.com/docs/datasheets/tc_ts_d.pdf

G. Occupancy Sensor: These sensors shall have passive dual technology (PDT) and internal relay option. Provide Sensorswitch Model WV-PDT-16-R sensors with WV-BR ceiling mounting brackets. The power source is 24 VAC/VDC, and shall be provided by the BAS controller. This is a stocked-item at OPP Stores, and can be furnished by Laface & McGovern, Altoona Office; contact Dan Cowen, 814-944-6373.

2A.8 THERMOSTATS

A. Combination Thermostat and Fan Switches: Line-voltage thermostat with two-, three-, or four-position, push-button or lever-operated fan switch.

1. Label switches "FAN ON-OFF," "FAN HIGH-LOW-OFF," "FAN HIGH-MED-LOW-OFF." Provide unit for mounting on two-gang switch box.

B. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, integral manual on-off/auto selector switch.

1. Equip thermostats, which control electric heating loads directly, with off position on dial wired to break ungrounded conductors.

2. Dead Band: Maximum 2 deg F (1 deg C).

C. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature, with copper capillary and bulb, unless otherwise indicated.

1. Bulbs in water lines with separate wells of same material as bulb.

2. Bulbs in air ducts with flanges and shields.

3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit, adequately supported.

4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.

5. On-Off Thermostat: With precision snap switches, with electrical ratings required by application.

6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

D. Room thermostat located on exterior walls: Shall include insulating base.

E. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet (6 m). For a Coil more than 20 ft², provide 1 ft (3 m) of sensing element for each 1 ft² (1 m²) of coil area.

2A.9 VALVE AND DAMPER ACTUATORS

A. Electronic direct-coupled actuation shall be provided.

B. The actuator shall be direct-coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a "V" bolt design with associated "V" shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a "V" clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or screw type fasteners are not acceptable.
C. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.

D. For power failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are acceptable for valves larger than 4”.

E. All spring return actuators shall be capable of both clockwise and counterclockwise spring return operation.

F. Proportional actuators shall accept a 0 to 10VDC or 0 to 20mA analog control input and provide a 2 to 10VDC or 4 to 20mA operating range. An actuator capable of accepting a pulse width modulating control signal is not acceptable. An actuator capable of accepting a three-point floating control signal is not acceptable.

G. All 24VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10VA for AC or more than 8 watts for DC applications. Actuators operating on 120VAC power shall not require more than 10VA. Actuators operating on 230VAC shall not require more than 11VA.

H. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque shall have a manual crank for this purpose.

I. All modulating actuators shall have an external, built-in switch to allow reversing direction of rotation.

J. Actuators shall be provided with a conduit fitting.

K. Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association Class 4813 02 certified as meeting correct safety requirements and recognized industry standards.

L. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of start-up, per Start-up Report or Cx documentation. Manufacturer shall be ISO9001 certified.

2A.10 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Globe Valves NPS 2 (DN 50) and Smaller: Bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.

C. Globe Valves NPS 2-1/2 (DN 65) and Larger: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.

D. Hydronic system globe valves shall have the following characteristics:
   1. Rating: Class 125 for service at 125 psig (862 kPa) and 250 deg F (121 deg C) operating conditions.
   2. Internal Construction: Replaceable plugs and seats of stainless steel or brass.
      a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
      b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
   3. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate.
4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Operators shall close valves against pump shutoff head.

E. Butterfly Valves: 200-psig (1380-kPa), 150-psig (1035-kPa) maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.

2. Disc Type: Elastomer-coated ductile iron.
3. Sizing: 1-psig (7-kPa) maximum pressure drop at design flow rate.

F. Pressure Independent Control Valves

1. Manufacturers:
   a. BELIMO AIRCONTROLS (USA), INC.
   b. GRISWOLD

2. The modulating control valves shall be pressure independent.
3. The control valves shall accurately control the flow from 0 to 100% full rated flow with an equal percentage flow characteristic. The flow shall not vary more than +/- 5% due to system pressure fluctuations across the valve with a minimum of 5 PSID across the valve.
4. Forged brass body rated at no less than 400 PSI, chrome plated brass ball and stem, female NPT union ends, dual EPDM lubricated O-rings and TEFZEL characterizing disc.
5. Combination of actuator and valve shall provide a minimum close-off pressure rating of 200 PSID.
6. The control valve shall require no maintenance and shall not include replaceable cartridges.
7. All actuators shall be electronically programmed by use of a handheld programming device or external computer software. Programming using actuator mounted switches or multi-turn actuators are NOT acceptable. Actuators for two-position ½"-1" pressure independent control valves shall fail in place and have a mechanical device inserted between the valve and the actuator for the adjustment of flow. Actuators shall be provided with an auxiliary switch to prove valve position.
8. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory via a single screw on a four-way DIN mounting-base.
9. The control valve shall require no maintenance and shall not include replaceable cartridges.
10. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
11. The use of pressure independent valves piped in parallel to achieve the rated coil flow shall be permitted. Actuators shall be electronically programmed to permit sequencing the flow with a single control output point. The use of external devices to permit sequencing is NOT acceptable.

G. Terminal Unit Control Valves: Characterized Ball, Forged brass body, Stainless Steel trim, two- or three-port as indicated, replaceable plugs and seats, union and threaded ends.

1. Rating: Class 125 for service at 125 psig (862 kPa) and 250 deg F (121 deg C) operating conditions.
2. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head. Select control valves for a minimum Cv of 1.0 to reduce the risk of system dirt accumulating in very small orifices in characterizing-discs.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

2A.11 CONTROL PANEL 120-Volt ENCLOSED POWER SUPPLY
A. Each BAS Control Panel (including the Building Controller) shall have a “packaged” Power Supply in a separate enclosure, such that the BAS Control Panel door can be opened without exposure to the hazards of 120-Volt wiring connections (Arc-Flash hazard).

B. The CSC shall use the PSH Series by Functional Devices, Inc. The specific Model will vary with specific power requirements at that Control Panel. An Approved Equal is acceptable.

C. The Enclosed Power Supply shall be installed, according to the Manufacturer's instructions, in the upper-left corner inside the BAS Control Panel.

2A.12 COMBINATION AIR FLOW / TEMPERATURE MEASUREMENT STATION (AFMS):

A. Manufacturers:
   EBTRON, Inc. Gold Series (basis of design)

B. General: Provide thermal dispersion type, combination airflow and air temperature measurement devices where indicated on the drawings and/or control sequences. Each measuring device shall consist of multi-point sensor nodes in one or more probe assemblies with a maximum of sixteen sensor nodes per location, and a single remotely mounted 32-bit microprocessor-based transmitter for each measurement location. Airflow/Temperature measuring devices shall be UL Listed as an entire assembly. Devices in UL-labeled enclosures are not equivalent and are not acceptable without a UL Listing for Standard 873.

1. Design and installation shall use duct or plenum mounted devices to fullest extent possible.

2. Fan inlet sensors shall not be substituted for duct or plenum sensor probes.
   a. Exception: where conditions otherwise make duct/plenum installation impractical and justifications of exceptions are reviewed with University and manufacturer’s authorized representative.
   b. Where fan inlet mounting is otherwise unavoidable, mounting styles shall be indicated on the plans as either “face mounting” or “throat mounting.” Face mounting shall provide no mechanical fastening in the throat or on the surface of the inlet cone and shall be used on all performance-sensitive plenum-type or plug fans.

3. The manufacturer’s authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans. A written report shall be submitted to the consulting mechanical engineer prior to installation if any measurement locations do not meet the manufacturer’s placement requirements.

4. Field Installation: Install in accordance with manufacturer’s placement instructions for optimum performance at the locations indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any discrepancies are found.

5. Adjustment: Duct and plenum devices shall not be adjusted without approval from the consulting mechanical engineer. Fan inlet mounted devices may be adjusted during start up and commissioning only after having been checked against known volumetric values (or against another like device measuring the same air volume) at two or more points of operation.
C. Sensor Assembly: Each sensing point shall independently determine the airflow rate and temperature at each node, which shall then be equally weighted in calculations by the transmitter prior to output as the cross-sectional average. No electronic components other than the sensor elements shall be located at the sensing node. Each ducted sensor probe shall have an integral, U.L. Listed, plenum rated cable. Cable jackets and conductor insulation shall be FEP, Teflon-FEP or Neoflon-FEP. Conductor insulation for internal probe wiring shall be Kynar. Devices which average multiple non-linear variables are not acceptable. Pitot arrays are not acceptable. Devices using chip-in-glass, epoxy-coated or diode-case chip thermistors are not acceptable. Vortex-shedding devices are not acceptable.

1. Each independent airflow sensor shall have a sensor accuracy of +/-2% of Reading over the entire calibrated airflow range of 0 to 5,000 fpm (25.4 m/s for ducted or plenum mounted probes, or not less than 0 to 10,000 fpm (50.8 m/s) for fan inlet mounted sensors. All sensor nodes shall be wind tunnel calibrated to at least 16 air velocities against standards that are traceable to NIST.

2. Each independent temperature sensor shall have a calibrated accuracy of +/-0.14° F (0.08° C) over the entire operating temperature range of -20° F to 160° F (-28.9° C to 71° C) and be calibrated at 3 temperatures against standards that are traceable to NIST.

3. Devices whose accuracy is the combined and independent accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the calibrated range.

D. Transmitter: Each transmitter shall have a display capable of simultaneously displaying both airflow and temperature. Airflow rate shall be field configurable to be displayed as velocity or volumetric rates, selectable as IP or SI units. Each transmitter shall operate on 24 VAC and be fused and protected from over voltage, over current and power surges. All integrated circuitry shall be temperature rated as 'industrial-grade'.

1. Each transmitter shall be capable of transmitting individual velocity and temperature measurements for every sensing point in an array for a single location. The traverse data from each independent sensor shall be available as part of the network data packet transmitted via the BACnet protocol.

2. Each transmitter shall be capable of communicating with other devices using at a minimum the following interface option:

   a. Combined linear airflow and temperature analog output signals and one RS-485 network interface. This shall include: Two field selectable 0-5VDC / 0-10VDC / 4-20mA (4-wire) outputs, fuse protected and electrically isolated from all other circuitry; plus one field selectable network protocol: BACnet-MS/TP or BACnet-ARCNET. BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.

3. Transmitter shall include the following features: Enhanced Output Integration, Low Airflow Alarm functions for compliance with LEED Outdoor Air Delivery Monitoring credit and ASHRAE Standard 189.1 and a Field Calibration Wizard to simplify field setup for adjustments when desired.

2A.13 Bi-directional bleed airflow sensors (Thermal Dispersion Type):

A. General: Provide EBTRON, Inc. Silver Series Model STN104-B series Transmitter (basis of design) thermal dispersion type air airflow/pressure “bleed” sensors where indicated to measure and control to very low velocity/pressure differentials. The transmitter output shall be RS-485, BACnet-MS/TP to be capable of communicating with the BAS. Provide a manufacturer’s parts warranty for 36 months from the date of unit shipment. The manufacturer’s authorized representative shall review and approve placement and setup parameters for each measurement location indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the
manufacturer’s placement requirements.

B. Each measuring device shall consist of a factory calibrated sensor assembly of three hermetically sealed bead-in-glass thermistors in a glass filled polypropylene housing, with a “plug and play” cable, and a single, remotely mounted, microprocessor-based transmitter capable of field configuration and diagnostics, with a switching power supply, fused and protected from transients and power surges and circuitry to assure automatic reset after power disruption, transients and brown-outs. The operating airflow range shall be ±3,000 fpm and pressure range of –0.5 to +0.5 in w.c. Each measuring device shall have an accuracy of ±2% of reading over the entire operating airflow range, factory calibrated at a minimum of 10 airflow rates to standards that are traceable to the National Institute of Standards and Technology (NIST).

C. Provide duct/plenum mounting kits as applicable. Hardware shall include stainless steel face plates with connecting pipe and fittings. Provide correction coefficients to compensate for entry and friction loss of the entire assembly to convert the airflow rate to the equivalent pressure between adjacent zones. Provide a rain/snow shield for installations on exterior wall surfaces.

2A.14 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. An UPS is required to be installed to provide Power to every level of Controller serving emergency and/or critical equipment.

B. The UPS shall include dry-contacts for monitoring the UPS status.
PART 2B PRODUCTS, SOFTWARE

2B.1 SYSTEM SOFTWARE OVERVIEW

A. Acceptable Products:
   1. ALC: Eikon and WebCTRL are acceptable ALC System Software products.
   2. JCI: NAE, ADS, SCT, GX Tool and HVAC-PRO are acceptable JCI System Software products.

B. The CSC shall provide all software required for operation of the BAS system specified herein. All functionality described herein shall be regarded as a minimum. The CSC shall provide the following as a minimum:
   2. Configuration of all controller and operator workstation application programs to provide the sequence of operation indicated.
   3. An electronic copy of each and every controller program installed in all Primary Equipment, Terminal Equipment, or other programmable controllers for the Project. File-names shall include Equipment Tag and Date in MMDDYYYY format.
   4. All Configuration Tools, and all software licenses, required to configure all controllers installed on this project.

2B.2 SYSTEM CONFIGURATION

A. Database Creation and Modification. All changes shall be done utilizing standard procedures. The system shall allow changes to be made either at the local site through a portable computer or central workstation.

B. The system shall permit the operator to perform, as a minimum, the following:
   1. Add and delete points/objects
   2. Modify point parameters
   3. Create and modify control sequences and programs
   4. Reconfigure application programs

C. All data points/objects within the database shall be completely accessible as independent or dependent variables for custom programming, calculation, interlocking, or manipulation.

D. The University shall be provided with a software account that has unlimited privileges for the entire site installation.

2B.3 APPLICATION PROGRAMMING

A. The system software shall include Graphic Programming or Line Programming for all DDC control algorithms resident in individual control modules. This programming shall be used to create the sequences of operation necessary to complete a control sequence. Graphical-blocks or Line-programming shall represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors, etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each graphical-block or line-programming routine shall be interactive and contain the programming necessary to execute the function of the device it represents.

B. Programming shall be performed while on screen and using a mouse; each graphical-block or line-programming routine shall be selected from a library and assembled with other blocks or routines necessary to complete the specified sequence. Blocks or routines are then interconnected by forming logical connections. Once assembled, each logical grouping of blocks or routines and their interconnections then forms a program which may be used to control any piece of equipment with a similar point configuration and sequence of operation.
C. The clarity of the programming sequence must be such that the user has the ability to verify that system programming meets the specifications. The programming must be documented to provide the user with an understandable and exact representation of each sequence of operation.

D. Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs. The programming language shall have the following features:

1. The language shall be Graphical or English language oriented, and allow for free-form programming (i.e., not column-oriented or "fill in the blanks").

2. A full-screen character editor/programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete custom programming code. It also shall incorporate features such as cut/paste and find.

3. The programming language shall allow independently executing program modules to be developed.

4. The editor/programming environment shall have a debugging capability that shall provide error messages for syntax and execution errors.

5. The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

6. The programming language shall support floating-point arithmetic using the following operators: +, -, /, x, square root, and x-to-the-y-power. The following mathematical functions also shall be provided: natural log, log, trigonometric functions (sine, cosine, etc.), absolute value, and minimum/maximum value from a list of values.

7. The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the language so that interval-timing functions can be stopped and started within a program. Values from all of the above variables shall be readable by the language so that they can be used in a program for such purposes as IF/THEN comparisons, calculations, etc.

8. The language shall be able to read the values of the variables and use them in programming statement logic, comparisons, and calculations.

2B.4 DIRECT DIGITAL CONTROL SOFTWARE

A. The system shall continuously perform DDC functions at the local control module in a stand alone mode. The operator shall be able to design and modify the control loops to meet the requirements of the system being operated. The operators shall use system provided output for tuning of PID loops.

B. Each local control module should perform the following functions:

1. Identify and report alarm condition

2. Execute all application programs indicated on the Object Table(s)

3. Execute DDC algorithms

4. Trend and store data

C. In the event of a control module power failure, all points/objects under it's control shall be commanded to the failure mode as indicated on the Object Table(s). All DDC software shall reside in the respective control module.

1. Power failures shall cause the control module to go into an orderly shutdown with no loss of program memory.
2. Power failure at any control module shall be reported at the Operator Workstation.

3. The restart program shall automatically restart affected field equipment. The operator shall be able to define an automatic power up time delay for each piece of equipment under control.

2B.5 SOFTWARE USER INTERFACE

A. The on-line graphics, scheduling, and events shall be created using the Automated Logic WebCTRL or JCI Metasys System Extended Architecture software.

B. For this project, at least one (1) additional simultaneous-user license for the existing campus Automated Logic WebCTRL or JCI Metasys System Extended Architecture software shall be provided. (This is the same requirement, just a repeat wording location, as in “Scope of Work, System Software, Site-license”.)

C. All of the system objects, schedules, and events shall be represented as BACnet objects by the CSC.

D. Events (Alarms):
   1. The CSC shall provide all alarm event notification and alarm events messages for objects on the object table provided to and approved by the University’s Physical Plant BAS Group.
   2. Alarm event notification, alarm event messages, and event routing shall be in accordance with the existing PSU standards.
   3. CSC implemented events objects:
      a. All Input/Output objects listed on the object tables for each piece of equipment shall have an event defined for the off-normal condition.
      b. Analog objects shall list the high and low alarm limits.
      c. Every device connected to the system shall also be alarmed for an off-line condition. The CSC shall provide a BACnet BV for the offline status.
         (1) Three notification classes shall be defined to route alarms.
            a. Critical alarms shall be printed, logged, and pop-up windows shall occur via an email notification.
            b. Maintenance level alarms shall be printed and logged.
            c. Commissioning alarms shall be printed and logged.
      d. The event objects and routing shall be reviewed by the University’s Physical Plant BAS Group to identify the class, routing, limits, and message content for each object prior to CSC implementation.
      e. An event shall be generated for a device communications failure or a device program changing to a halt or failure state. All devices shall have this feature implemented.

E. On-line Graphics:
   1. The on-line graphics shall be provided by either an approved Automated Logic Corporation (ALC) dealer or an approved JCI dealer. The on-line graphics submittal shall be submitted to the CSC to be included with the Shop Drawing Submittal, for review and approval by the University’s Physical Plant BAS Group.
   2. On-line Graphics Submittal by the CSC shall include a list of the color graphic screens to be provided and sample graphics for each unique mechanical system and a dynamic thermo-graphic Floor Plan.
   3. All mechanical equipment (Primary, Terminal, etc.) shall have a representative graphic.
4. System Summary Graphics:
Each integrated building-wide system or combination of systems, and each central plant system, shall have a separate graphic that accurately represents the relative order/arrangement of equipment and components as installed, and shows the inter-relationships and inter-dependence between key components of each system and combination of systems.

   a. Example-1: when multiple pieces of mechanical equipment within a “system” are intended to operate in series or parallel, with a duty/standby or lead/lag sequence of operation.
   b. Example-2: when primary equipment supply units and zone/terminal distribution units have associated exhaust fans that are linked for overall pressure control, or airflow control.
   c. Example-3: chiller “plants” shall schematically show key components of the main system, including multiple chillers, cooling towers, pumps, isolation and temperature/flow control valves and interconnected piping. Include summary of connected load equipment cooling requests.
   d. Example-4: heating “plants” shall schematically show key components of the main system, including multiple boilers, combustion air dampers, fuel gas valves, pumps, isolation and temperature/flow control valves and interconnected piping. Include summary of connected load equipment heating requests.

5. All mechanical equipment shall also have a graphic representing the logic programming: An on-line graphical representation of the programming logic with real-time values, accessible via the standard thin-client user interface program Microsoft Internet Explorer preferred; OR vendor-supplied toolset will be acceptable.

6. There shall also be a graphics screen for each communication trunk showing the communication status for each device connected to the system.

   a. The graphic shall use layout and/or text to represent where each control device is located and the actual physical riser connections of the control modules and network accessories (i.e. repeaters, network protection devices, etc.).
   b. If a device is in communications failure, the controller color shall be magenta. If the device communications status is normal, the controller color shall be green.
   c. The program run state of each device shall also be displayed on the communication trunk graphic. If the program is in the normal running state
the color should be green. If it is in the halted or failure state, the color should be magenta.

7. AreaServed/Equipment graphic
   a. The CSC shall provide a Floor Plan graphic representing the spaces served by each piece of Primary Equipment (Air systems, and Heating-only systems). The Floor Plan graphic will include the Room Numbers of the Spaces being served, and the Spaces shall be color-shaded to indicate they are served by the noted Primary Equipment.
   b. Floor Plans shall dynamically update to visually depict the Zone alarm (event) status of the Spaces being served, just as with the Floor Plan dynamic thermo-graphics.
   c. If the Primary Equipment serves Spaces on several Floors, the AreaServed/Equipment graphic will be comprised of portions of several Floor Plans.
   d. This AreaServed/Equipment graphic will be available from the Equipment graphic and from the Floor Plan dynamic thermo-graphic (as described below) that represents the difference between Zone Temperature and Zone Set-Point.

8. Floor Plan dynamic thermo-graphics.
   a. All floors in the building shall have a graphic screen.
   b. Equipment locations and space temperatures shall be displayed on the floor plan graphic.
   c. Hypertext links to the room controller parameters shall be defined by clicking on the room location the controller serves.
   d. Hypertext links to equipment parameters shall be defined by clicking on the equipment location on the floor plan.
   e. Dynamic thermo-graphics shall be defined for each Zone controller to visually depict the Zone alarm (event) status of the room(s). The color-coding is defined below.

9. If the actual space temperature is in the dead band between the heating setpoint and the cooling setpoint, the color displayed shall be green for the occupied mode, representing ideal comfort conditions. If in the unoccupied mode, the color displayed shall be gray representing 'after-hours' conditions.

10. If the space temperature rises above the cooling setpoint, the color shall change to yellow. Upon further rise beyond the cooling setpoint plus an offset, the color shall change to orange. Upon further rise beyond the cooling setpoint plus the yellow band offset, plus the orange band offset, the color shall change to red indicating unacceptable high temperature conditions. At this point an alarm shall be generated to notify the operator.

11. When space temperature falls below the heating setpoint, the color shall change to light blue. Upon further temperature decrease below the heating setpoint minus an offset, the color shall change to dark blue. Upon further space temperature decrease below the heating setpoint minus the light blue band offset minus the dark blue band offset the color shall change to red indicating unacceptable low temperature conditions. At this point an alarm shall be generated to notify the operator.

12. Two submissions of online Graphics are required. Refer to the Schedule of CSC’s milestones:
   a. Initial set of online graphics (systems and dynamic thermo-graphic floorplans), shall be ready for use by the Cx-provider before verification of Inputs and Outputs.
   b. Complete revisions to the initial set of online graphics, at the same time as submitting as-builts BAS Shop Drawings.
13. All graphics screens shall be reviewed, coordinated and approved by the University’s Physical Plant BAS Group prior to implementation.

F. Equipment Occupancy Scheduling:
1. All equipment occupied/unoccupied scheduling shall be accomplished via a BACnet BV that is controlled by a BACnet schedule.
2. The CSC shall provide a BACnet BV for all VAVs, FCUs, Air Handlers, Exhaust equipment to be implemented in schedules.
3. Equipment schedules shall be coordinated between the University Project Management and the University customer.
4. The system shall allow the operator to designate any combination of equipment to form a group that can be scheduled with a single operator command through the mouse interface at the workstation.
   a. Any designated group shall have the capability to be a member of another group.
   b. The operator shall be able to make all schedule additions, modifications and deletions using the mouse and appropriate dialog boxes. In addition, the operator shall have the capability to edit all schedules and then download any or all schedule changes to the control modules with a single operator command through the mouse interface.
   c. The operator shall be able to view a color-coded forecast of schedules for instant overview of facilities schedules. Schedule graphic forecast shall include colored coded indication of all types of schedules, i.e. normal, holiday and override.

G. The following applications software, per “programs” in System Points/Objects List(s), shall be provided for the purposes of 1) emergency utility demand limiting and 2) optimizing energy consumption while maintaining occupant comfort:
1. Emergency Utility Demand Limiting Strategies
   Install controllers implementing a demand-limiting strategy consistent with the Sequences of Operation Guideline available at Enterprise Utility Management System (EUMS) Equipment Control Strategies on the PSU Design Standards website. The demand-limiting strategies shall be submitted, reviewed and approved by the University’s Physical Plant BAS Group prior to implementation.

2. Time Scheduling
   The system shall be capable of scheduling by individually controlled equipment and groups of individually controlled equipment. Each schedule shall provide beginning and ending dates and times (hours:minutes). The CSC shall provide a BACnet BV for scheduling by the CSC.

3. Demand Limiting (DL) - Temperature Compensated
   a. The DL application shall be programmable for a minimum of six separate time of day kW demand billing rate periods. The system shall be capable of measuring electrical usage from multiple meters serving one building and each piece of equipment being controlled on the LAN shall be programmable to respond to the peak demand information from its respective meter.
   b. The demand control function shall utilize a sliding window method with the operator being able to establish the kilowatt threshold for a minimum of three adjustable demand levels. Sliding window interval shall be operator selectable in increments of one minute, up to 60 minutes. Systems that incorporate rotating shed tables will not be acceptable.
c. The operator shall have the capability to set the individual equipment temperature setpoints for each operator defined demand level. Equipment shall not be shed if these reset setpoints are not satisfied, rather the setpoint shall be revised for the different established demand levels. The system shall have failed meter protection, such that when a kW pulse is not received from the utility within an operator adjustable time period, an alarm will be generated. The system software will automatically default to a predetermined fail safe shed level.

d. The system shall have the ability to archive demand and usage information for use at a later time. System shall permit the operator access to this information on a current day, month to date and a year to date basis.

4. Reset (Source Temperature Optimization (STO))

a. The system shall automatically perform source optimization for all air handling units, chilled water and heating water systems in response to the needs of other downstream pieces of equipment, by increasing or decreasing supply temperature setpoints, i.e. chilled water, discharge air, etc. using University defined parameters. In addition to optimization, the STO capability shall also provide for starting and stopping primary mechanical equipment based on zone occupancy and/or zone load conditions.

b. The STO program will allow setpoints for various equipment in the heating/cooling chain to be reset between an University defined maximum and a minimum setpoint based on the actual requirements of the building zones. The actual setpoint shall be calculated based on the number of heating or cooling requests which are currently being received from the equipment or zones served. Once every update period, the STO program surveys the network to see if any piece of equipment requires any additional heating or cooling from its source.

c. As an example, a VAV air handler is the source of cold air for a number of VAV boxes. Assume that the STO program for the air handler has the following parameters established for it by the University’s Physical Plant BAS Group:

1. Optimized setpoint description: Initial setpoint 60.00, Max. setpoint 65.00, Min. setpoint 55.00. Every 2.0 minutes, trim by 0.25 and respond by -0.50 but no more than 2.0. Every two minutes, the STO program will total up all of the requests and calculate a new setpoint: New setpoint = prev setpoint + 'trim by' + ('respond by' x no. of req.). Assuming four requests were received and the previous setpoint was 57.00 degrees, the new setpoint would be: New setpoint = 57.00 + 0.25 + (-0.50 x 4) = 55.25 Deg F

2. If the number of requests received multiplied times the 'respond by' value is greater than the 'but no more than' value, the 'but no more than' value is used inside the parenthesis in the above calculation.

5. Set Back/Set Up (Day/Night Setback (DNS))

a. The system shall allow the space temperature to drift down or up within a preset (adjustable) unoccupied temperature range. The heating or cooling shall be activated upon reaching either end of the DNS range and shall remain activated until the space temperature returns to the DNS range.

b. The system shall be capable of closing all outside air and exhaust air dampers during the unoccupied period, except for 100% outside air units.

c. Unoccupied space temperature shall be monitored by the DDC temperature sensors located in the individual zones being controlled or within a representative room in the building if full DDC control is not being effected.
User shall be able to define, modify or delete the following parameters:

1. DNS setpoint temperature(s)
2. Temperature band for night heating operation
3. Period when the DNS is to be activated

6. Timed Local Override (TLO)
   - The system shall have TLO input points/objects which permit the occupants to request an override of equipment which has been scheduled OFF. The system shall turn the equipment ON upon receiving a request from the local input device. Local input devices shall be push button (momentary contact), wind-up timer, or ON/OFF switches as detailed in the Object Table(s).
   - If a push button is used the system operator shall be able to define the duration of equipment ON time per input pulse and the total maximum ON time permitted. Override time already entered shall be canceled by the occupant at the input point. If a wind-up timer is used the equipment will stay in override mode until the timer expires. Year to date, month-to-date and current day override history shall be maintained for each TLO input point. History data shall be accessible by the operator at any time and shall be capable of being automatically stored on hard disk and/or printed on a daily basis.

7. Space Temperature Control (STC)
   - There shall be two independently-adjustable space temperature setpoints, one for cooling and one for heating, separated by a dead band. Only one of the two setpoints shall be operative at any time. The cooling setpoint is operative if the actual space temperature has more recently been equal to or greater than the cooling setpoint. The heating setpoint is operative if the actual space temperature has more recently been equal to or less than the heating setpoint. There are two modes of operation for the setpoints, one for the occupied mode (example: heating = 72 degrees F, cooling = 76 degrees F) and one for the unoccupied mode (example: heating = 55 degrees, cooling = 90 degrees F). NOTE: it will no longer be acceptable to accomplish having a Heating Setpoint and a Cooling Setpoint by having a single mid-range setpoint with offsets.
   - The occupied/unoccupied modes may be scheduled by time, date, or day of week via a BACnet BV.
   - All setpoints and offsets shall be operator definable. When in the occupied mode, start-up mode, or when heating or cooling during the night setback unoccupied mode, a request shall be sent over the network to other equipment in the HVAC chain, such as to an AHU fan that serves the space, to run for ventilation. The operator shall be able to disable this request function if desired.
   - The cooling and heating setpoints may be increased (decreased) under demand control conditions to reduce the cooling (heating) load on the building during the demand control period. Up to three levels of demand control strategy shall be provided. The operator may predefine the amount of setpoint increase or decrease for each of the three levels. Each space temperature sensor in the building may be programmed independently.
   - An optimum start-up program transitions from the unoccupied setpoints to the occupied setpoints. The optimum start-up algorithm considers the rate of space temperature rise for heating and the rate of space temperature fall for cooling under nominal outside temperature conditions; it also considers the outside temperature; and the heat loss and gain coefficients of the space envelope (AI: Space Temperature).
f. A PID control loop, comparing the actual space temperature to its setpoint, shall modulate the dampers and heating coil valve or heating stages in sequence to achieve the setpoint target.

8. Historical Data and Trend Analysis: A variety of Historical data collection utilities shall be provided to automatically sample, store, and display system data in all of the following ways.
   a. Continuous Point Histories: Global Building Controllers /Routers shall store Point History Files for all analog and binary inputs and outputs. The Point History routine shall continuously and automatically sample the value of all analog inputs at half hour intervals. Samples for all physical hardware input and output points shall be collected during the warranty period, to allow the user to immediately analyze equipment performance and all problem-related events. Point History Files for binary input or output points and analog output points shall be archived on the server workstation hard drive.
   b. Control Loop Performance Trends: Global Building Controllers /Routers shall also provide high resolution sampling capability with an operator-adjustable resolution of 10-300 seconds in one-second increments for verification of control loop performance.
   c. Extended Sample Period Trends: Measured and calculated analog and binary data shall also be assignable to user-definable trends for the purpose of collecting operator-specified performance data over extended periods of time. Sample intervals of 1 minute to 2 hours, in one-minute intervals, shall be provided. Each standalone Global Building Controller /Router shall have a dedicated buffer for trend data, and shall be capable of storing a minimum of 5000 data samples.
   d. Data Storage and Archiving: Trend data shall be stored at the Global Building Controllers /Routers, and uploaded to hard disk storage when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full. All trend data shall be available in disk file form for use in 3rd Party personal computer applications.

9. Runtime Totalization: Global Building Controllers /Routers shall automatically accumulate and store runtime hours for binary input and output points as specified.
   a. The Totalization routine shall have a sampling resolution of one minute or less.
   b. The user shall have the ability to define a warning limit for Runtime Totalization. Unique, user-specified messages shall be generated when the limit is reached.

10. Analog/Pulse Totalization: Global Building Controllers /Routers shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.
    a. Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g., KWH, gallons, KBTU, tons, etc.).
    b. The Totalization routine shall have a sampling resolution of one minute or less.
    c. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

11. Event Totalization: Global Building Controllers /Routers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event Totalization shall be performed on a daily, weekly, or monthly basis.
a. The Event Totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

b. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

--- End of PART 2 --------------------------
PART 3 EXECUTION

3.1 EXAMINATION
A. Verify that systems are complete and ensure that the systems are capable of being started and operated in a safe and normal condition before attempting to operate the BAS systems.
B. Beginning of work means acceptance of existing conditions.

3.2 GENERAL INSTALLATION
A. Install equipment level and plumb.
B. Install software in control units and, as applicable, in laptop computer(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
C. Connect and configure equipment and software to achieve sequence of operation specified.

3.3 WIRING DEMOLITION
A. All wiring and tubing abandoned by the work of the CSC, during the course of completing this Project, shall be removed in total.
B. Controllers, Panels and Devices abandoned by the Scope of this Project, shall be retained by PSU Physical Plant Area Services. Area Services Technicians shall be given 10 days notice for them to remove these items.

3.4 WIRING INSTALLATION
A. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division 26 sections of these specifications.
B. Provide all interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with requirements of applicable Specification Division 26 sections and all national, state, and local electrical codes. All the wiring shall be installed in accordance with the current National Electrical Code (NEC).
C. Provide wiring as required by functions as specified and as recommended by equipment manufacturer's to serve specified control functions.
D. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the University's Physical Plant BAS Group's representative prior to rough-in.
E. The term "control wiring" is defined to include the providing of wire, conduit, and miscellaneous materials as required for mounting and connecting electric or electronic control devices in pilot circuits of contactors, starters, relays, etc., and wiring for valve and damper operators.
F. Install signal, communication, and fiber-optic cables according to Division 26 Section "Control/Signal Transmission Media", and as follows:
   1. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
   2. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
G. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
H. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
I. Provide auxiliary pilot duty relays on motor starters as required for control function.

J. All exposed control wiring and control wiring in the mechanical, electrical, telephone, and similar rooms shall be installed in raceways. All other wiring shall be installed neatly and inconspicuously above ceilings.

K. Install exposed control wiring system in conduit for electric/electronic control systems. Conceal wiring, except in mechanical rooms and areas where other conduit and piping are exposed. UL plenum-rated cable shall be provided when located in ceiling spaces. All control wiring shall be installed in a neat and workmanlike manner parallel to building lines with adequate support. Both conduit and plenum wiring shall be supported from or anchored to structural members. Conduit or plenum wiring supported from or anchored to piping, duct supports, the ceiling suspension system, is not acceptable. Wiring buried in slab-on-grade concrete or explosion-proof areas shall be in rigid metal conduit. Provide adequate strain relief for all field terminations.

L. Number-code or color-code conductors, excluding those used for individual zone controls, appropriately for future identification and servicing of control system.

3.5 CONTROL DEVICE INSTALLATION

A. All room sensors and thermostats shall be mounted so as to be accessible in accordance with ADA Guidelines, unless otherwise noted on the drawings. It is the CSC’s responsibility for final coordination of the sensor/thermostat locations with the Professional and the University’s Physical Plant BAS Group.

B. Enhanced Zone Sensors shall be installed only in private or semi-private Offices, and Conference Rooms. These shall not be installed in Public Spaces.

C. Provide averaging-type sensors in mixing plenums, and at hot and cold decks. Install averaging-type sensors in a serpentine manner vertically across the duct cross-section. Support each bend with a capillary clip.

D. Install low-limit duct thermostats (freezestats) in a serpentine manner horizontally across the face of coil. Provide 1 ft (3 m) of sensing element for each 1 ft² (1 m²) of coil area.

E. Remote control devices not in local panels shall be accessible for adjustment and service below 7' above finished floor whenever possible.

F. Locate all temperature control devices wired under Division 26.

G. Install guards on thermostats in the following locations:
   1. Entrances.
   2. Public areas.
   3. Where indicated.

H. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

I. Local controllers shall be mounted at eye level for accessibility and service, and located within 50’ of the system served, unless otherwise shown on the plans.

J. Freestanding enclosures and panels shall be supported on steel unistrut frames, or approved equal, and be securely anchored to the floor and be well braced.

K. Enclosures and panels mounted directly to the wall shall be provided with a minimum airspace of 1” between the enclosure and the wall.

L. A minimum of 3’ working clearance shall be provided in front of all enclosures and panels; clearance shall be ensured to permit the enclosure door to open at least 90° from its closed position.

M. Mounting height shall be a maximum 6’-6” to the top of the enclosure.
N. Shall be suitable for use in environments having an ambient temperature range of 31°F to 104°F and a relative humidity of up to 95% noncondensing.

O. There shall be no pneumatic equipment or device installed in a Global Building Controller/Router enclosure. There shall be no equipment or device installed in a Global Building Controller/Router that is not a functional component of the campus system interface or building BAS system.

P. A padlocking hasp and staple or keyed cylinder shall be provided for each door.

Q. A field-installed, 14-gage galvanized steel drip shield shall be provided where enclosures and panels may be subjected to dripping water.

3.6 INSTALLATION OF AIRFLOW MEASUREMENT DEVICES

A. Installation

1. Install in accordance with manufacturer’s placement instructions for optimum performance at the locations indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any discrepancies are found.

B. Adjusting

1. Duct and plenum devices shall not be adjusted without approval from the consulting mechanical engineer.

2. Fan inlet mounted devices may be adjusted during start up and commissioning only after having been checked against known volumetric values (or against another like device measuring the same air volume) at two or more points of operations.

3.7 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Ground equipment: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.8 CONTROL POWER

A. Power supply for Global Building Controllers/Routers and associated BAS components shall be connected via a dedicated circuit to the building normal-emergency panel. A grounding conductor shall be run from building service entrance panel ground bus. Conductor shall be insulated and isolated from other grounded conductors and building conduit system.

B. Power supply for Application Controllers used to monitor emergency equipment and/or equipment serving critical spaces (i.e. Animal Rooms, Computer Server Rooms, etc.) shall be connected via a dedicated circuit to the building normal/emergency panel.

C. UPS: Uninterruptible Power Supply(s) shall supply power for the Global Building Controller(s), repeater(s) and/or Application Controllers that monitor or serve emergency and/or critical equipment. The dry-contacts for monitoring the UPS status shall be monitored by the BAS.

D. Provide power for Application Controllers and all associated control components from nearest electrical control panel or as indicated on the electrical drawings—coordinate with Electrical Contractor.

E. Power for each control panel shall be provided through a switch (standard light switch) located inside the panel. A standard duplex receptacle shall also be provided inside the control panel. The receptacle shall be unswitched. Control transformer(s) shall be located outside the control panel, and attached to the side of the panel.

3.9 IDENTIFICATION
A. The CSC shall label each system device with a point address or other clearly identifiable notation inside the device cover. Labels shall be permanent, and method of labeling shall be approved by the University’s Physical Plant BAS Group.

B. All control equipment shall be clearly identified by control shop drawing designation as follows:
   1. Control valves and damper actuators: brass tags or engraved phenolic (Bakelite) tags.
   2. Other Remote Control Devices: Metal tags or laser printed, adhesive backed, metalized polyester film labels.
   3. Control Enclosures and Panels: Engraved nameplate with panel number and system served.

C. Duct static-pressure sensors and piping differential-pressure sensors locations shall be:
   1. indicated on the Installation Mark-up Drawings (kept on-site) for transfer of this information onto the As-Builts; and
   2. identified on the BAS Floor Plan online graphic; and
   3. identified in the building using a sticker/label on the nearest ceiling grid, or access-panel where concealed.

3.10 TRENDS

A. All input and output control and status points will have trends set-up and enabled. Each trend will store a minimum of 500 samples in the associated controller utilizing a first-in/first-out algorithm so that the oldest data is over-written as new data is stored. The controller will also be programmed for the capability of enabling historical trending on each trended point individually so that historical trending can be enabled on any point without enabling it on any other trended point.

B. All trends shall be programmed to be triggered according to the type of point, as follows:
   1. All equipment start/stop control point trends will be triggered on the control point’s change of state.
   2. All equipment status point trends will be triggered on the status point’s change of state.
   3. All space-temperature and outside-air trends will be triggered on any change of value of 2 degrees Fahrenheit.
   4. All space-humidity and outside-air-humidity trends will be triggered on any change of value of 5%.
   5. All fan air temperature trends will be triggered on any change of value of 5 degrees Fahrenheit.
   6. All water temperature trends will be triggered on any change of value of 3 degrees Fahrenheit.
   7. All damper motor control point trends will be triggered on any change of value of 10% of it’s control range.
   8. All valve control point trends will be triggered on any change of value of 10% of it’s control range.
   9. All VFD motor control point trends will be triggered on any change of value of 5% of it’s control range.
  10. All fan air static pressure trends will be triggered on any change of value of .05 inches water column.
  11. All water pressure trends will be triggered on any change of value of 3 psi.
12. All steam pressure trends will be triggered on any change of value of 2% of the steam pressure input range.

3.11 ALARMS
A. All Input/Output objects listed on the object tables, for each piece of equipment, shall have an event (alarm) defined for the off-normal condition.
B. Analog objects shall list the high and low alarm limits.
C. Every device connected to the system shall also be alarmed for an off-line condition. The CSC shall provide a BACnet BV for the offline status.
   1. Two notification classes shall be defined to route alarms.
      a. Critical alarms shall be printed, logged, and pop-up windows shall occur via an email notification.
      b. Maintenance level alarms shall be printed and logged.
D. The event objects and routing shall be reviewed by the University’s Physical Plant BAS Group to identify the class, routing, limits, and message content for each object prior to implementation.
E. An event shall be generated for a device communications failure or a device program changing to a halt or failure state. All devices shall have this feature implemented.

3.12 SCHEDULES
A. A list of schedules to be implemented shall be reviewed and approved by the Professional. The list shall also include the schedule times (Occupied and Unoccupied) to be implemented.

3.13 BASIC SYSTEM REPORTS AND CUSTOM TRENDS
A. Basic System Reports shall be set-up, a minimum of one per System, that provide a Summary of values of the key Points in that System, at the same point-in-time ("snapshot"). Some Reports might require multiple “pages” for viewing. Contact the BAS Group for examples.
B. Reports shall be created using Microsoft Excel spreadsheets.
C. Basic System Reports for HVAC Systems Functional Performance & Diagnostics
   1. General Intent: To assess ongoing functional performance through continued monitoring and useful reporting through the BAS of the actual operating conditions of the controls and interactions of the HVAC systems. Coordinate and integrate building reporting requirements with campus EUMS to avoid duplication or omission of reporting requirements.
   2. Reports shall be initially set up by BAS vendor to be able to be manually or automatically run at user’s option, and sent out periodically via email to user defined list to achieve the following goals:
      a. Verifying design intent and functional performance
      b. Diagnosing comfort and other space condition problems
      c. Alert users to inefficient or improper operation of equipment
      d. Maintaining persistence of energy savings
      e. Demonstrating effects of poor maintenance or identifying when maintenance procedures are not followed
f. To provide data that can be further used in spreadsheets to assist in studying alternative strategies

3. Reports shall be organized according to the project specific applications. They shall include summaries of key setpoints, control status (optimized reset, auto vs. overridden) and actual controlled conditions.

   a. For example, reports shall provide, at a glance, a summary of the % cooling demand at all zone terminals, and corresponding cooling requests at zone level causing reset of Supply air temperature at AHU and unmet SAT setpoint at AHU level, causing DP reset at chilled water pump and/or chilled water supply temperature reset at chiller level.

   b. Example reports in Excel spreadsheet format. Request e-file “BAS Performance Reports.xlsx” from the BAS Group. Contact: Bob Mulhollem, Manager of Environmental Systems, The CSC shall provide a minimum of 10 Custom Trends, to be set-up by the CSC after the Cx-provider has begun Functional Performance Testing. These Custom Trends are in addition to the Trends for all input and output control and status points noted above, and will mostly involve display of multiple trends in the same view (i.e. Trend Graph or Trend Study). The Cx-provider will provide 15-calendar-days advance notification of when the Custom Trends need to be completed.

4. In general, include reports at each of the following levels and for each of the systems within those levels and key indicators that show interactions between systems:

   a. **Zone Level Systems**
      1. Thermal Comfort/Environmental Conditions
      2. Terminal Heating and Cooling Equipment
      3. Smoke & other distribution control dampers (position status)
      4. Other (as required)

   b. **Primary Equipment and Central Plant Level Systems**
      1. Air Handling Units
         a. Coil/Energy Transfer
         b. Ventilation and Pressurization: Supply, Return, Outside Air quantities
         c. Fan
      2. Auxiliary
         a. Pumps (chilled, condenser and hot water)
         b. Exhaust fans
            1. General
            2. Purpose
            1. Cooling Plant Equipment
               a. Campus Chilled Water
b. Chillers
c. Cooling Towers
d. Heat exchangers

2. Heating Plant Equipment
   a. Boilers
   b. Heat Exchangers
c. Decentralized Level Systems
   1. Packaged Unitary DX Equipment
   2. Heat Pumps
   3. Other (as required)

D. Custom Trends:
The CSC shall provide a minimum of 10 Custom Trends, to be set-up by the CSC after the Cx-provider has begun Functional Performance Testing. These Custom Trends are in addition to the Trends for all input and output control and status points noted above, and will mostly involve display of multiple trends in the same view (i.e. Trend Graph or Trend Study). The Cx-provider will provide 15-calendar-days advance notification of when the Custom Trends need to be completed.

3.14 ACCEPTANCE OF COMPLETED BAS INSTALLATION

A. Acceptance of the completed BAS installation includes verification of the proper equipment communication setup. This shall be accomplished by submitting a BACnet network analysis capture for a period of 5-minutes. The capture file (in .TXT format) shall be submitted to the University’s Physical Plant BAS group for Review and Approval. The Physical Plant BAS group Approval shall be received, and any identified problems shall be resolved before Acceptance Testing shall begin. Corporate assistance shall be requested and used as necessary to resolve any network-issues in a timely fashion.

B. Upon completion of the installation, the CSC shall start up the system and perform all necessary calibration, testing, and debugging operations. An acceptance test shall be performed by the CSC in the presence of the University’s Physical Plant BAS Group representative. Acceptance test shall be scheduled with at least 10 working days advance notice. The acceptance test shall be observed by at least one member from the University’s Physical Plant BAS group.

C. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
   2. Test and adjust controls and safeties.

D. Replace damaged or malfunctioning controls and equipment.
   1. Start, test, and adjust control systems.
   2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

E. The acceptance test shall include, but not be limited to:

1. The CSC shall submit a checklist of the objects for the test. The checklist shall be submitted to the University’s Physical Plant BAS Group, and reviewed and approved by the University’s Physical Plant BAS Group, prior to the test. The checklist shall include all objects that have event (alarm) routing defined.

2. The CSC and OEM manufacturer shall verify the proper operation of all input/outputs.

3. The CSC shall verify the proper event (alarm) routing to Physical Plant BAS operations center for all points on the main equipment and perform a spot check of the operations of ten percent of terminal units equipment.

4. The CSC shall verify that the software programs meet the design intent of the control sequences in the Construction Documents.

5. The CSC shall verify the proper operation of the system software on the operator workstation.

6. The CSC and the OEM manufacturer shall verify all inputs meet or exceed manufacturer’s stated tolerances for accuracy.

7. The CSC shall verify that all on-line graphical displays of equipment accurately represent the real time state of the field equipment.

8. The CSC shall verify that all on-line graphical displays of programming logic accurately represent the real time state of the field equipment.

9. The CSC shall verify the reliability of all communications of all field devices to the appropriate operator workstation located in the Physical Plant Building.

10. The test shall include all workstation/server level integration included in the scope of this project with the CSC and OEM manufacturers.

11. The test shall include functional verification of all interfaces and system integration required to meet the scope of this project.

12. Final acceptance shall include acceptance by the University’s Physical Plant BAS Group.

13. The Acceptance Test shall be conducted with the CSC, OEM manufacturer, the Prime Contractor representative and a member of the University’s Physical Plant BAS Group present.

F. Turnover of ALARMS to PSU BAS Operators: Alarms being turned-over to PSU BAS Operators shall have been activated, tested for proper routing and determined to not be producing frequent and nuisance alarms. It is expected that Alarms will not be turned-over to PSU BAS Operators until there is final acceptance of the completed BAS installation.

G. Acceptance: When the field test procedures have been successfully demonstrated to the University’s Physical Plant BAS Group and the system performance is deemed satisfactory, the system parts will be accepted for beneficial use and placed under warranty. At this time, a "notice of completion" shall be issued by the University’s project representative and the warranty period shall start.

H. All of the points which are alarmed shall be trended and archived from the time of installation through the end of the warranty period. All archived files will be readily accessible to the University’s Physical Plant BAS Group.

I. Start-up and commission systems: Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
J. Provide any recommendation for system modification in writing to the University’s Physical Plant BAS Group. Do not make any system modification, including operating parameters and control settings, without prior approval of the University’s Physical Plant BAS Group.

K. Provide certificate stating that control system has been tested and adjusted for proper operation.

L. Project Record Documentation: After a successful acceptance testing, submit project record drawings of the completed project for final approval. After receiving final approval, supply four (or as specified in Division 1) complete project record sets (maximum ANSI “D” size), together with an electronic version on CD to the University’s Project Management. The electronic version shall simultaneously be provided at the BAS Group’s FTP site, and the University’s Physical Plant BAS Group shall be notified. Notify Bob Mulhollem, Manager of Environmental Systems, REM26@psu.edu, 863-7220.

M. Equipment Panel As-Built Drawings: After the above final approval, one set for the entire project shall be provided in the Building Controller Panel, and a paper-copy set of just the Drawings for that System shall be provided in each System Panel, and the University’s Physical Plant BAS Group shall be notified. Notify Bob Mulhollem, Manager of Environmental Systems, REM26@psu.edu, 863-7220.

3.15 TRAINING

A. The CSC shall provide factory-trained instructor to give full instructions to designated personnel in the operation, maintenance, and programming of the system. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The training shall be specifically oriented to the system and interfacing equipment installed.

B. Instructions shall include 2 parts, the “New BAS Equipment Classroom-Orientation” and the “BAS Product Training” as outlined below:

1. New BAS Equipment “walk-through” sessions will be conducted by the PSU Technician that has been assisting with New Building (or Major Renovation) Commissioning.

2. New BAS Equipment Classroom-Orientation: Two (2) 3-hour Classroom-sessions for the University’s Technical Service employees. This shall be an overhead/onscreen presentation of the online BAS interface and include showing how to access, and use, information about any portion of the new project’s BAS.
   a. Handouts (20 copies) will include the construction mark-ups of the BAS Shop Drawing submittal, and shall be clearly noted on the Cover-page with “FOR TRAINING ONLY. (Date) DO NOT COPY”, and shall be turned-over to the Training Coordinator at the end of the Classroom sessions. Alternate: A minimum of 5 Printed Handouts, and presentation using 2 projectors and 2 screens, including 1 projector and screen dedicated to displaying the BAS Shop Drawing Page being discussed.
   b. General - One session will be more general in nature for the Area Services and Weekend personnel who will be initial responders, dealing mostly with “Too Hot” or “Too Cold” calls.
   c. Technical – One session will be more technical, being oriented for the Central Services personnel that will need to troubleshoot more complex problems.
   d. Schedule Classroom-sessions with the University giving at least ten days advance notice. Provide an Agenda, to be approved by the University’s Physical Plant BAS Group prior to scheduling Training. To schedule sessions, contact the Physical Plant Training Coordinator at 814/ 863-2340.

3. Project Specific BAS Product Training: This contract shall provide “Factory Training Credits” with a value equal to 1% (0.01 times) of the scheduled BAS work for this
Project. This training shall be provided during the period of installation, OR at the University’s option, banked for use following the installation period of this contract.

a. Submit a “Letter of Factory Training Credits” as part of the BAS Shop Drawings Submittal (see Part 1). Include Project Name, CSC Project Manager, Total Value of BAS Contract and Date.

b. "Factory Training Credits” shall be used to engage a factory-authorized service representative to train University's maintenance personnel on-site to adjust, operate, and maintain control systems and components.

c. Train University's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, Operation of portable operator's terminal and maintaining equipment and schedules.

d. Provide operator training on modification of data display, alarm and status descriptors, requesting data, executing command, calibrating and adjusting devices, resetting default values, and requesting logs.

e. Provide a student binder with training modules.

f. Schedule BAS Product Training sessions with the University with at least twenty (20) days advance notice. Provide an Agenda, to be approved by the University’s Physical Plant BAS Group, prior to scheduling Training. To schedule, contact the Physical Plant Training Coordinator at 814/ 863-2340.

3.16 ADJUSTING AND CLEANING

A. Start-up: Start-up, test, and adjust electric control systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer’s touch-up paint.

C. Final Adjustment: After completion of installation, adjust sensors, thermostats, control valves, motors, and similar equipment provided as work of this section. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.

--- End of PART 3 --------------------------
PART 4 SEQUENCES OF OPERATION

A. HVAC EQUIPMENT – Refer to HVAC drawings, H6.XX series.

1. Note that in addition to the sequences provided in the H6.XX series drawings the contractor shall also provide monitoring of other systems and points including chilled water flow (see detail 2/H9.10), steam flow (see detail 10/H8.10) and condensate flow metering (see detail 11/H8.10) for use by OPP.

2. IN ADDITION TO CONTROLS OF HVAC EQUIPMENT THE CONTRACTOR SHALL ALSO CONTROL AND/OR MONITOR OTHER BUILDING SYSTEMS AS DESCRIBED BELOW:

B. PLUMBING EQUIPMENT

1. Domestic Hot Water Heater: Controller supervised by BAS. Refer to Plumbing equipment schedules for sequence by local controller.

2. Domestic Hot Water Recirculation Pump: Pump shall operate when any HVAC zone is in occupied mode and the measured return temperature in the loop drops below 100˚ F. Monitor status through the BAS.

3. Provide metering information for the domestic water usage through the BAS back to OPP for use by OPP.


C. DEFINITIONS

1. Night Lighting refers to non-emergency exterior lights mounted to the building. These “night” lights are usually controlled by the campus master photocell. “Night” Lighting does not include exterior lighting for the site (walkway, roadway, or parking) or egress lighting to the Public Way.

D. INTERIOR PUBLIC SPACE LIGHTING

1) Interior Lighting Control - BAS shall schedule when to enable or disable local control of interior corridor and public space lighting via CAT-6 Cable to the EC provided lighting control panel (typically a motorized breaker panel).
   • Unoccupied Hours - After 6:00 PM the lighting controller will turn lighting zone off. Provide a local override switch within each zone to allow occupants to give local control back to the occupancy sensors for a period of 2 hours (adjustable).
   • Note: Programming of the building lighting control panel by EC shall be such that it’s sequence of operation can be modified to force on lighting during the occupied hours (with no control via local occupancy sensors) and then allow local occupancy sensor control during unoccupied hours.

2) Building Mounted Lighting Control – Control of building mounted lighting shall match that of Site/Night Lighting Control.

3) Status: Status shall be determined via data interface of building lighting panel to BAS by BAS contractor.
   [Note difference between Interior and Exterior Lighting Status:
   • Status for interior lighting zones is via data transfer between lighting controller interface and BAS.
   • Status for exterior and building mounted lighting zones is via current sensor input to the BAS.

4) Alarm: An alarm shall indicate when a lighting zone has been turned on, but the status remains off.
5) Hours-of-Use: An accumulated-time indicating the total on hours until reset.

E. SITE (WALKWAY, ROADWAY AND PARKING) & NIGHT LIGHTING

Each circuit shall have I/O for control and status. When any Site and/or Night Light type of exterior lighting circuit is included in a Project, the following shall be provided:

1) Site/Night Lighting Control: BAS shall signal the EC provided lighting control panel to energize or de-energize the Night and/or Street Lighting circuit(s) via CAT-6 cable. Each exterior lighting circuit shall be controlled by each of the following means:
   - automatically via astronomic capability in the Application Controller(s) with I/O for the Exterior lighting circuit(s)
   - via BAS network communications, using the Lighting Master Point at Physical Plant
   - a software toggle, manual On/Off control from a BAS graphic
   - a hardware Hand-Off-Auto(BAS control) for each group of circuits (i.e. one each for night, walkway, roadway, and parking – as required)
   - Exterior Emergency Lighting: Utilize a non-latching relay to control an electrically held, normally closed lighting contactor. BAS shall open the contactor (hold lights off) during daytime hour (dawn to dusk). Any failure within the system shall put the lights in the “on” position.

2) Status: Status shall be determined via a current sensor (typically split-core, 0-30 A input: 4-20 mA output), set-up in software to indicate On status with a current in excess of 35% (adj.) of total circuit current. Where there are multiple phases, each phase shall be monitored. Contractor shall utilize a true rms meter to measure total circuit current (per phase) with all lamps confirmed operable.

3) “Maintenance” Alarm: A “Maintenance” Alarm shall indicate when a lighting circuit has been commanded On, but the current sensor has a reading of less than 75% (adj.), but greater than 35% (adj.) of total circuit current.
   [The INTENT is to know when the lights are On and all but 1 or 2 of the lamps are functioning. When more than 35% of the lamps are burned out, The Status will indicate On, but initiate a Maintenance Alarm.]

4) “Off Normal” Alarm: An “Off Normal” Alarm shall indicate when a lighting circuit has been commanded On, but the Status remains Off. This condition shall occur when the current sensor has a reading between 0% and 35% (adj.) of total circuit current.

5) “On Hand” Alarm: An “On Hand” Alarm shall indicate when a lighting circuit has been commanded Off, but the Status remains On. This condition shall occur when the current sensor has a reading greater than 5% (adj.) of total circuit current.

6) “Over-current” Alarm: A “Over-current” Alarm shall indicate when a lighting circuit has been commanded On and the current sensor has a reading of greater than 110% (adj.) of total circuit current value measured during the initial setup (refer to paragraph 2).

7) Hours-of-Use: An accumulated-time, indicating the total On hours until Reset.

F. ELECTRICAL SERVICE ENTRANCE EQUIPMENT

1) Arc Flash Reduction Mode: BAS shall monitor the Arc Flash Reduction Mode ARMS in the electrical service entrance equipment (usually the main Switchgear).
   - Initiate a four (4) hour countdown timer until Alarm.
   - Note: Electrician should call into CCS to notify that they are putting the building into arc flash reduction mode. If the electrician hasn’t put the building back to normal mode prior to leaving that site, an Alarm shall notify the CCS operator to contact that
electrician as to whether the work is complete. If the electrician has left for the day and the electrical gear is not back in normal mode, the CCS operator should notify the electrical integrity crew supervisor of this issue so that the building can be put back into normal mode.

G. EMERGENCY SYSTEMS

1) Automatic Transfer Switch (ATS) [NOTE: Automatic Transfer Switches exist in many different applications, including where there is an Emergency Generator, a Fire Pump, or Emergency Standby HVAC equipment. EACH Automatic Transfer Switch needs to include indication of normal and emergency source voltage availability, status, and alarm, per the following.]

   a) Normal Source (Preferred) Voltage Availability: The CSC shall use the contacts provided by the ATS Manufacturer/ Electrical Contractor. These contacts shall indicate an acceptable source voltage based on ATS settings.

   b) Emergency Source (Non-Preferred) Voltage Availability: The CSC shall use the contacts provided by the ATS Manufacturer/ Electrical Contractor. These Contacts shall indicate an acceptable source voltage based on ATS settings. Loss of acceptable source voltage shall be Alarmed in the BAS.

   c) Status: The CSC shall use the NC contact of the Manufacturer-installed SPDT auxiliary contacts in the Emergency Transfer Switch to provide an input indicating the Status of the ATS.

   d) Alarms:

       1) The Status of the ATS shall be Alarmed in the BAS, to indicate any time the ATS has switched to the Emergency source.

       2) ATS Normal to Emergency Switch Failure – Once the normal source voltage available alarms, program a 90 second timer to monitor contact showing ATS in emergency position. If contact does not change state in that time, initiate alarm.

       3) ATS Emergency to Normal Switch Failure (situation starting with no normal source available) - Once the normal source voltage becomes available, program a 35 minute timer to monitor the ATS normal position contact. If contact does not change state in that time, initiate alarm.

BAS FIGURES:
Figures 1 and 2 follow on the next two pages.
Automated Logic System Architecture

ALC BACnet
WebCTRL Server

Client Workstations
Running Internet Explorer

Campus IP Routing Infrastructure

LGR Global Building BACnet Router
BACnet MS/TP or ARCNET (CMNet)

ME-Line Controller

ME-Line Controller

NOT PERMITTED as shown

LGR Global Building BACnet Router
BACnet MS/TP or ARCNET (CMNet)

ME-Line Controller

S-Line Controller

ZN-Line Controller

BACnet Portal (As Required)

3rd-Party Sub-system Equipment [RTU(s), Chiller(s), etc.]

LGR Global Building BACnet Router
BACnet MS/TP or ARCNET

M-Line Controller

SE-Line Controller

ZN-Line Controller

Figure 1: Building Automation System with Automated Logic Corporation product:

Figure 2: Building Automation System with Johnson Controls Inc. NAE product:
SECTION 260000 - ELECTRICAL SYSTEMS GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE

A. Furnish all labor, materials and equipment as required for new electrical work and as shown on Drawings and described below:

B. Provide and install all electrical systems, including but not limited to, lighting, power, fire alarm and low voltage systems as shown or implied in the contract documents for a complete and functional installation in accordance with OSHA and NEC requirements.

C. Electrical Contractor shall provide and install all lighting and power wiring and connect each motor and its control and shall provide roughing and receptacles or boxes for all equipment requiring the same.

D. Before ordering any material or doing any work, the Electrical Contractor shall check and verify all measurements, including lines, grades, pipe and duct elevations at the building and shall be responsible for the correctness of same.

E. Electrical Contractor shall provide temporary power as necessary for the construction phase and comply with state, local and regulating authorities. Contractor will coordinate and verify in the field with the General Contractor for the necessary equipment, panels, etc, including locations required to serve and accommodate the temporary power requirements.

1.2 TERMINOLOGY

A. “Provide” shall mean furnish and install, make all final connections and leave in an approved operating condition.

B. “Electrical work” or “work” shall mean all labor, transportation, material, equipment, scaffolding, rigging, tools, installation, supervision, services, and any other incidental items or services necessary for a complete and operable installation.

C. “Wiring” shall include the conductor, raceways, and connections to the equipment, apparatus, outlets and other specialties.

D. “Conductor”, “wire”, and “cable” shall mean insulated conductor.

1.3 DRAWINGS

A. The drawings accompanying this specification form a part of the Specification upon which the work shall be based. Drawings are not to be scaled.

B. Drawings are diagrammatic, small scale and indicate only the general arrangement of systems and work included.
C. Consult the architectural and mechanical drawings for exact location of fixtures and equipment. Where same are not definitively located, obtain this information from the Architect.

1.4 INTENT

A. It is the intention of the drawings and specifications to call for clean finished work, tested, and ready for operation.

B. Any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation, even if not particularly specified or shown, shall be provided without additional expense. Minor details not usually shown or specified, but manifestly necessary for the proper installation and operation the various systems, shall be included in the work, the same as if specified or shown on the drawings.

C. The Electrical Contractor shall be responsible for assuring that his proposed systems can be installed as required from the drawings and specifications. If any departures from the drawing and specification are deemed necessary by the Contractor, details or such departures and the reasons therefore shall be submitted to the Architect for approval. No such departures shall be made without the prior written approval of the Architect.

1.5 ALTERATIONS TO EXISTING ELECTRICAL WORK

A. Should removal, relocation, rerouting of another Division's work be required to accommodate Division 26 work, the Electrical Contractor shall be responsible for that work and shall pay all required costs. Work shall be performed by mechanics skilled in particular trade involved; that is, plumbing work by plumbers, electrical work by electricians, mechanical work by steamfitters and sheet metal mechanics.

B. Existing wiring, which is to remain in service under the new arrangement, shall be modified, extended, rerouted and connected to existing available circuit or to new circuit. If existing wiring is found not to be in satisfactory condition, provide written notification to replace with new wiring of type required for new arrangement for owner's review and approval.

C. Existing electrical work that has become exposed due to new arrangement, and is to remain in service, shall be relocated, modified, extended as required to suit the new arrangement.

D. Existing equipment, building areas, or surfaces damaged, during alterations, shall be restored to their original condition or replaced.

E. Electrical Contractor shall provide temporary electrical service for any existing equipment, or systems required to be maintained in operation during the construction. Final connections to this equipment shall be provided when the required permanent electrical services are installed completely.

1.6 CONTINUITY OF SYSTEMS

A. Electrical work shall be done at such time, and in such manner, as will least interfere with the maintenance and operation of any existing facilities included in the work. Provisions shall be made to permit use of all existing electrical systems at all times. Provide temporary facilities to secure these conditions and remove such temporary facilities when no longer required.
B. Shutdown for disconnecting existing electrical facilities and connecting new electrical work shall be made at such time and in such manner as directed by the University.

C. Where shutdown periods cannot be of duration to accommodate the new work, the Subcontractor shall perform the work in a series of preplanned stages of minimal allowable shutdown periods. Provide temporary facilities to allow re-energizing of service between working stages.

1.7 STRUCTURAL CONDITIONS AND COORDINATION OF WORK

A. Electrical Contractor shall carefully examine all architectural and structural drawings for the buildings and all drawings for other trades, and shall be responsible for the proper fitting of his material into the buildings as planned, without interference with other work.

B. Electrical Contractor shall carefully investigate the structural and finish conditions affecting all his work and arrange his work accordingly; furnishing such fittings, bends, etc., as may be required to meet such conditions.

C. All electrical fixtures, equipment, ducts, wiring, etc., shall be installed so as not to interfere with other pipelines, plumbing or electrical fixtures, electrical raceways, etc. All work shall be installed so as to preserve proper access. Pipe hanger, conduit, ductwork, etc., in the immediate vicinity of any piece of equipment shall be located as to leave all parts of the equipment accessible for maintenance and conforms to the minimum Working Space Conditions of the National Electrical Code.

D. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes and standards. Use consistent designations throughout Project.

E. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

F. Coordinate installation of identifying devices with location of access panels and doors.

G. Install identifying devices before installing acoustical ceilings and similar concealment. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

H. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

I. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

J. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

1.8 SCAFFOLDING, RIGGING, HOISTING

A. Provide scaffolding, ladders, rigging, hoisting and all other equipment required for the installation of electrical work.
1.9 PAINTING

A. All electrical equipment such as circuit breaker enclosures, switchboards, panelboards, disconnect switches, enclosed motor starters, lighting fixtures, etc., shall be furnished with factory applied finish, including prime, under and finished coats of paint.

B. If factory finish surfaces become damaged or deteriorated, restore the surface to the original condition, to the satisfaction of the Architect.

1.10 PASSAGE OF EQUIPMENT

A. Establish passage clearances required to deliver, install, and erect electrical equipment

B. Where there is not sufficient clearance for passage of electrical equipment into the building, deliver, set and protect such equipment before confining walls, floors, slabs, steel work are erected. Install the equipment before restraining enclosures are erected.

C. If structure, equipment and systems must be altered to provide passage of equipment, the Electrical Contractor shall restore structures, equipment and systems to their original condition, at no additional cost.

1.11 INSPECTION, ADJUSTING AND CLEANING

A. At the completion of the project, the Electrical Contractor shall make thorough inspection of all the electrical work. At the final inspection, all systems must be 100 percent complete, and tests shall be performed in strict compliance with this specification.

B. Where the work of the Electrical Contractor will be installed in close proximity to work of other trades, or where there is evidence that the work of the Contractor will interfere with the work of Other Trades, he shall assist in working out space to make a satisfactory adjustment.

C. If the Electrical Contractor installs work before coordinating with Other Trades, or so as to cause interference with work of Other Trades, the Electrical Contractor shall make necessary changes in his work to correct the condition without extra charge.

D. The Electrical Contractor shall locate all equipment, which must be serviced, operated or maintained in fully accessible positions. Equipment shall include, but not be limited to panels, motors, and controllers, pull boxes, etc. If required for better accessibility, Contractor shall furnish approved access doors for this purpose. Minor deviations from drawings may be made to allow for better accessibility, but changes of magnitude or which involve extra cost shall not be made without approval of the Architect.

E. Where conduit runs in close proximity to heating piping or domestic hot water piping, the minimum space between pipes and conduits shall be six inches (6").

F. The Electrical Contractor shall maintain maximum headroom and space conditions at all points. Where headroom or space conditions appear inadequate, the Architect shall be notified before proceeding with installation.

G. Architect shall be informed of any change in major overall dimensions as shown on the Electrical Drawings effecting the physical size, shape or location of any part of the layout, whether due to field conditions or changes due to the use of equipment of manufacturer other than those listed. The Architect must approve any changes.
1.12 CLOSE OUT

A. Provide electronic copy of “as-built” drawings in DWG and PDF formats.

1.13 TESTING

A. ELECTRICAL ACCEPTANCE TESTING

1. Testing shall be performed on electrical equipment and systems to assure that equipment and systems are operational and within applicable standards and manufacturer’s tolerances. Testing should verify that equipment and systems are installed in accordance with design specifications. All testing shall occur at the building site.

2. Testing shall be performed by an independent organization that is professionally independent of the manufacturers, suppliers, and installers of the equipment or systems being evaluated. The name of the proposed testing organization shall be submitted to Engineering Services for approval.

3. Qualified technicians who are trained and regularly employed for testing services shall do all testing. Submit technician qualifications.

4. The testing organization shall conform to the general guidelines of section 5 of the latest NETA Acceptance Testing Specifications, in their entirety. This includes the following:
   a. Safety and Precautions
   b. Suitability of Test Equipment
   c. Test Instrument Calibration
   d. Test Report

5. Provide report in the Megger “Power DB” program. Furnish one (1) original, editable electronic (.mdb format), one (1) electronic PDF copy, and Four (4) paper copies of the completed report to Engineering Services. Have the testing firm contact Engineering Services to procure PSU standard Power DB testing forms.

6. Notify Engineering Services at least seven (7) days in advance of any testing. A representative of Engineering Services shall witness testing. All testing shall be video taped.

7. Inspection and testing of all applicable electrical equipment listed below shall be done in accordance with the latest version of NETA ATS. This will include all tests marked optional unless waived in writing by Engineering Services.
   a. Switchgear and Switchboard Assemblies
   b. Transformers: Air Cooled and Liquid Filled
   c. Cables: Low and Medium Voltage
   d. Air Switches:
1) Medium Voltage, Metal Enclosed

e. Vacuum Switches: Medium Voltage

f. Low Voltage Circuit Breakers:
   1) Insulated Case/Molded Case (100 amp frame and larger)
   2) Power

g. Medium Voltage Circuit Breakers:
   1) Air
   2) Oil
   3) Vacuum
   4) SF6

h. Circuit Switchers

i. Network Protectors

j. Protective Relays

k. Instrument Transformers

l. Metering

m. Grounding Systems

n. Ground Fault Protection Systems

o. Motors: AC and DC

p. Motor Starters: Low and Medium Voltage

q. Adjustable Speed Drive Systems

r. Direct Current Systems:
   1) Batteries
   2) Battery Chargers

s. Surge Arresters
   1) Low Voltage Surge Protection Devices
   2) Medium Voltage Surge Protection Devices

t. Emergency Systems:
   1) Uninterruptible Power Systems
   2) Automatic Transfer Switches
B. System Function Tests
   1. Perform system function tests upon completion of equipment tests as defined in 260000.1.12.4. It is the purpose of the system function tests to prove the correct interaction of all sensing, process, and action devices.
   2. Verify the correct operation of all safety devices for fail-safe functions in addition to design function.
   3. Verify the correct operation of all sensing devices, alarms, and indicating devices.

C. Thermographic Survey
   1. Perform a thermographic survey on all current carrying devices. Perform the survey during periods of maximum possible loading and prior to expiration of warranty or bond period.
   2. Imaging equipment shall be capable of detecting a minimum of 1-degree Celsius at 30 degrees Celsius.
   3. Level 2 certified thermographer shall perform the survey.
   4. A report shall be submitted to Engineering Services which includes the following:
      a. Description of equipment tested
      b. Discrepancies
      c. Temperature difference between area of concern and reference area
      d. Areas inspected
      e. Load conditions at time of inspection
      f. Provide photographs and/or thermograms of deficient areas
      g. Summary which includes recommendations for corrective actions.

D. Electromagnetic Field Testing
   1. Determine the vector-valued quantity of magnetic flux density for power frequency magnetic fields over a predetermined space or area, as designated by Engineering Services.
   2. Testing shall be done in accordance with the latest version of NETA ATS.

E. Voltage Drop Testing
   1. A voltage test shall be made at the last receptacle of each branch circuit of each Panelboard. Total voltage drop shall not exceed 3% of the initial voltage measured at the end of that branch circuit. The test shall be made using a 12A load attached to the furthest receptacle. Contractor is responsible to correct any installation with a voltage
drop of greater than 3%. If a branch circuit fails the test, all other branch circuits on that panel shall be tested. Submit all test results to Engineering Services.

2. Documentation of the results shall be provided to Engineering Services.

3. Any non-conforming branch circuits shall be corrected.

F. Fire Alarm Testing

1. All connected fire alarm devices are to be tested for operation, proper programming, and verified to meet proper sequence of operation. Printout of full system test showing test of all devices and interconnected systems shall be provided. Test is to include all sprinkler flow sprinkler tamper devices, all duct detectors and associated fan shutdown, any smoke evacuation sequence, elevator recall, magnetic door hold or door closer devices, any fire alarm sub-system interconnection, etc. Final fire alarm testing is to be completed in the presence of a representative from the Office of Physical Plant – Engineering Services with sufficient prior notification.

2. System shall be tested for code compliant alarm audibility upon completion of construction.

3. Completed and accurate As-Built floor plans shall be used for final testing and copies of these drawings shall be turned over to the PSU representative immediately after testing. These plans shall include full floor plans showing all fire alarm devices with address and/or loop ID information. Also, a copy of the MXL program shall be turned over to PSU at that time.

END OF SECTION 260000
SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.
B. Related Sections include the following:
   1. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 DEFINITIONS
A. EPDM: Ethylene-propylene-diene terpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS
A. Qualification Data: For testing agency.
B. Field quality-control test reports.

1.6 QUALITY ASSURANCE
A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alcan Products Corporation; Alcan Cable Division.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Minimum conductor size shall be No. 12 AWG.
3.2 CONDUCTOR INSULATION AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

H. MC cable shall be allowed for wiring whips up to 72" long.

I. Class 1 Control Circuits: Type THHN-THWN, in raceway.

J. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

G. Provide separate neutral conductor for every interior branch circuit.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
   1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS
A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING
A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL
A. Refer to Division 26 Section "Electrical Systems General Provisions" for testing requirements.

END OF SECTION 26 05 19
SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes: Grounding systems and equipment.
B. Section includes grounding systems and equipment, plus the following special applications:
   1. Underground distribution grounding.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS
A. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
   1. Ground rods.
   2. Grounding for sensitive electronic equipment.
B. Qualification Data: For qualified testing agency and testing agency's field supervisor.
C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Instructions for periodic testing and inspection of grounding features at test wells grounding connections for separately derived systems based on NETA MTS.
      a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
      b. Include recommended testing intervals.
1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
   7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 2 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar unless otherwise noted.
2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
   1. Bury at least 24 inches below grade.
   2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Grounding Bus: Install in electrical and telecommunications equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

D. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.
### 3.3 EQUIPMENT GROUNDING

**A.** Install insulated equipment grounding conductors with all feeders and branch circuits.

**B.** Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.

**C.** Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

**D.** Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

**E.** Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

### 3.4 INSTALLATION

**A.** Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

**B.** Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Raceways and Boxes for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

3.5 LABELING

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.

1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.6 FIELD QUALITY CONTROL

A. Refer to Division 26 Section “Electrical Systems General Provisions” for testing requirements.

B. Grounding system will be considered defective if it does not pass tests and inspections.
C. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
   2. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
   5. Point to point grounding resistance between main grounding bus and all major electrical
      equipment frames: .5 ohms.

D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify
   Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.3 DEFINITIONS
A. EMT: Electrical metallic tubing.
B. IMC: Intermediate metal conduit.
C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS
A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS
A. Product Data: For the following:
   1. Steel slotted support systems.

1.6 INFORMATIONAL SUBMITTALS
A. Welding certificates.
1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Comply with NFPA 70.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
      g. Wesanco, Inc.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. **Powder-Actuated Fasteners:** Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. **Mechanical-Expansion Anchors:** Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.

3. **Concrete Inserts:** Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. **Clamps for Attachment to Steel Structural Elements:** MSS SP-58, type suitable for attached structural element.

5. **Through Bolts:** Structural type, hex head, and high strength. Comply with ASTM A 325.

6. **Toggle Bolts:** All-steel springhead type.

7. **Hanger Rods:** Threaded steel.

### 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

**A. Description:** Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

**B. Materials:** Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

### PART 3 - EXECUTION

**3.1 APPLICATION**

**A.** Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

**B.** Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

**C.** Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

### 3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
   6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
   7. To Light Steel: Sheet metal screws.
   8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.
3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi Insert value, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29
SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Nonmetal conduits, tubing, and fittings.
   3. Metal wireways and auxiliary gutters.
   4. Nonmetal wireways and auxiliary gutters.
   5. Surface raceways.
   7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:
   1. Division 27 Section "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. LEED Submittals:

   1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of
Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. AFC Cable Systems, Inc.
5. Thomas & Betts Corporation.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

D. EMT: Comply with ANSI C80.3 and UL 797.

E. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:
   a. Material: Steel.
   b. Type: compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

G. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
2.3 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Wiremold / Legrand.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Cooper Technologies Company; Cooper Crouse-Hinds.
   2. EGS/Appleton Electric.
   4. FSR Inc.
   5. Hoffman; a Pentair company.
   6. Hubbell Incorporated; Killark Division.
   7. Mono-Systems, Inc.
   9. RACO; a Hubbell Company.
   10. Spring City Electrical Manufacturing Company.
   12. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
D. Metal Floor Boxes:
   2. Type: Fully adjustable.
   3. Shape: Rectangular.
   4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

I. Device Box Dimensions: 4 inches by 2-1/8 inches by 2-1/8 inches deep.

J. Gangable boxes are allowed.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:
   1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.
   6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:
   1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
   2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of fiberglass.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Armorcast Products Company.
   b. Carson Industries LLC.
   d. NewBasis.
   e. Nordic Fiberglass, Inc.
   f. Oldcastle Precast, Inc.; Christy Concrete Products.
   g. Synertech Moulded Products; a division of Oldcastle Precast, Inc.

2. Standard: Comply with SCTE 77.
3. Color of Frame and Cover: Green.
4. Configuration: Designed for flush burial with closed bottom unless otherwise indicated.
5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
7. Cover Legend: Molded lettering, "ELECTRIC."
8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

2.6 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

   1. Tests of materials shall be performed by an independent testing agency.
   2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

   1. Exposed Conduit: GRC.
   2. Concealed Conduit, Aboveground: GRC.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

   1. Exposed, Not Subject to Physical Damage: EMT or RNC.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
   a. Mechanical rooms.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.

5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

6. Damp or Wet Locations: GRC.

7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.

   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.


   4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface raceways only where indicated on Drawings.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. A. Support conduit within 12 inches of enclosures to which attached.
I. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to RNC, Type EPC-40-PVC, before rising above floor.

J. Stub-ups to Above Recessed Ceilings:

1. Use EMT or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. Install pull wires in empty raceways. Use No. 12 non-ferrous or 200 lb nylon fish line. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

S. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

W. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
   d. Attics: 135 deg F temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC in damp or wet locations not subject to severe physical damage.

Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

Z. Support outlet and switch boxes from (2) adjacent studs.
AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

BB. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel. Back to back outlets in common walls are not allowed.

CC. Locate boxes so that cover or plate will not span different building finishes.

DD. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

FF. Set metal floor boxes level and flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.

2. Install backfill as specified in Division 31 Section "Earth Moving."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.

   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.

7. Underground Warning Tape: Comply with requirements in Division 26 Section "Identification for Electrical Systems."
3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33
SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   5. Silicone sealants.

B. Related Requirements:
   1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Advance Products & Systems, Inc.
      b. CALPICO, Inc.
      c. Metraflex Company (The).
      d. Pipeline Seal and Insulator, Inc.
      e. Proco Products, Inc.

   2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Carbon steel.
   4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Presealed Systems.
2.4 GROUT
A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS
A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS
A. Comply with NECA 1.
B. Comply with NEMA VE 2 for cable tray and cable penetrations.
C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44
SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS [C]

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.


D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
1.5  COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1  POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:
   1. Black letters on an orange field.
   2. Legend: Indicate voltage and system or service type.

C. Colors for Raceways Carrying Circuits at More Than 600 V:
   1. Black letters on an orange field.
   2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high letters on 20-inch centers.

D. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

E. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch-wide black stripes on 10-inch centers diagonally over orange background that extends full length of raceway or duct and is 12 inches wide. Stop stripes at legends.

F. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

G. Write-On Tags: Polyester tag, 0.015 thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

D. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.4 UNDERGROUND-LINE WARNING TAPE

A. Tape:
   1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
   2. Printing on tape shall be permanent and shall not be damaged by burial operations.
   3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
   1. Comply with ANSI Z535.1 through ANSI Z535.5.
   2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,.
   3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE,.

2.5 WARNING LABELS AND SIGNS

B. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

C. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.6 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting with rust proof screws. White letters on a black background for normal power and white letters on red background for emergency power. Minimum letter height shall be 3/8 inch.

2.8 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.10 DEVICE LABELING

A. Inscribe panel and circuit number on back of each device coverplate with indelible marker and provide tag inside device box.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with rust proof mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
   1. Outdoors: UV-stabilized nylon.
   2. In Spaces Handling Environmental Air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use
multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

J. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways, More Than 600 V: Snap-around labels. Install labels at 10-foot maximum intervals.

C. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl tape applied in bands. Install labels at 10-foot maximum intervals.

D. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

2. Power.

E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.

   a. Color shall be factory applied.
   b. Colors for 208/120-V Circuits:

      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.

   c. Colors for 480/277-V Circuits:

      1) Phase A: Brown.
      2) Phase B: Orange.
      3) Phase C: Yellow.
d. **Field-Applied, Color-Coding Conductor Tape:** Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

F. **Power-Circuit Conductor Identification, More than 600 V:** For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags.

G. **Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.**

H. **Conductors to Be Extended in the Future:** Attach write-on tags to conductors and list source.

I. ** Auxiliary Electrical Systems Conductor Identification:** Identify field-installed alarm, control, and signal connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

J. **Locations of Underground Lines:** Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
   1. Limit use of underground-line warning tape to direct-buried cables.
   2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

K. **Workspace Indication:** Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

L. **Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting:** Metal-backed, butyrate warning signs.
   2. Identify system voltage with black letters on an orange background.
   3. Apply to exterior of door, cover, or other access.
   4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
      a. Power transfer switches.
      b. Controls with external control power connections.

M. **Operating Instruction Signs:** Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

N. **Emergency Operating Instruction Signs:** Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.
O. Provide self adhesive wrap around label on conductors landed at each 100A and above frame size circuit breakers with phase information and circuit breaker identification. Labels shall be readily visible once deadfront cover is removed.

P. Nameplates for normal power equipment shall be black with white lettering.

Q. Nameplates for emergency power equipment shall be red with white lettering.

R. Inscribe panel and circuit number with indelible ink on the back of all coverplates and provide durable tag in each outlet box.

S. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
   a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2- inch- high label; where two lines of text are required, use labels 2 inches high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
   d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:
   a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
   b. Enclosures and electrical cabinets.
   c. Access doors and panels for concealed electrical items.
   d. Switchgear.
   e. Switchboards.
   f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
   g. Emergency system boxes and enclosures.
   h. Enclosed switches.
   i. Enclosed circuit breakers.
   j. Enclosed controllers.
   k. Variable-speed controllers.
   l. Push-button stations.
   m. Power transfer equipment.
   n. Contactors.
   o. Remote-controlled switches, dimmer modules, and control devices.
   p. Monitoring and control equipment.

END OF SECTION 26 05 53
1. RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes computer-based short circuit, protective device evaluation, protective device coordination and arc flash protection studies. Protective devices shall be set based on results of the studies.

1.3 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Studies shall be performed by, stamped and signed by a registered professional engineer in the state of Pennsylvania. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the Engineer for approval prior to work. A minimum of five (5) years experience in power system analysis is required for individual in charge of project.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.
1.6 **GENERAL REQUIREMENTS**

A. Short circuit, protective device evaluation, protective device coordination and arc flash protection studies shall be performed by the distribution equipment manufacturer or an independent firm currently involved in high and low voltage power system evaluation.

B. Studies shall be submitted to PSU Engineering Services prior to receiving final approval of distribution equipment show drawings and prior to release of equipment for manufacture. If formal completion of the studies may cause delay in equipment manufacture, approval from PSU Engineering Services may be obtained for a preliminary submittal of sufficient study data to ensure that selection of device ratings and characteristics will be satisfactory.

C. Studies shall include all portions of the electrical distribution system from the normal power incoming primary source, the emergency source, down to and including all panels and distribution equipment in the distribution system, as required to comply with NFPA 70E. Normal systems connections and those which result in maximum fault and/or arc flash conditions, shall be adequately covered in study.

D. The firm performing study shall demonstrate capability and experience to provide assistance during start up, if required.

E. Power system studies are required to confirm the adequacy of the ratings of all electrical system components and proper coordination settings of all circuit breakers. Studies shall not be used as a basis to compromise the electrical system and do not imply that short circuit ratings of distribution equipment and devices may be lower than those indicated on the drawings or specified herein.

F. Power distribution equipment manufacturer shall carry in their bid to the electrical contractor a sufficient allowance to provide modifications to equipment, if necessary, based on the results of the studies identified herein.

**PART 2 - PRODUCTS**

2.1 **COMPUTER SOFTWARE DEVELOPERS**

A. Basis-of-Design Product: Subject to compliance with requirements, provide SKM Systems Analysis, Inc. or a comparable product by one of the following:
   1. EDSA Micro Corporation.
   2. ESA Inc.

2.2 **COMPUTER SOFTWARE PROGRAM REQUIREMENTS**

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device
settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:
   a. Arcing faults.
   b. Simultaneous faults.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
   a. Circuit-breaker and fuse-current ratings and types.
   b. Relays and associated power and current transformer ratings and ratios.
   c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
   d. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
   e. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
   a. Special load considerations, including starting inrush currents and frequent starting and stopping.
   b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
d. Generator thermal-damage curve.
e. Ratings, types, and settings of utility company's overcurrent protective devices.
f. Special overcurrent protective device settings or types stipulated by utility company.
g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Switchgear and switchboard bus.
2. Distribution panelboard.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141 and IEEE 242.

1. Transformers:
   a. ANSI C57.12.10.
   b. ANSI C57.12.22.
   c. ANSI C57.12.40.
   d. IEEE C57.12.00.
   e. IEEE C57.96.

4. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:
1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

F. Equipment Evaluation Report:
1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study to support selection of instrument transformer ratios, protective relay characteristics and settings, fuse ratings, low-voltage circuit breaker ratings, characteristics and settings.

B. Study shall demonstrate that the protective devices as selected and set will ensure that the minimum unfaulted load is interrupted when protective devices isolate a fault or overload anywhere in the system while satisfactory protection is provided for equipment against overloads, and short circuits are interrupted as rapidly as possible.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

D. Comply with IEEE 141 recommendations for fault currents and time intervals.

E. Transformer Primary Overcurrent Protective Devices:
1. Device shall not operate in response to the following:
   a. Inrush current when first energized.
   b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
   c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

F. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that
equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

G. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
   a. Device tag.
   b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
   c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
   d. Fuse-current rating and type.
   e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company’s upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

H. Completed data sheets for setting of overcurrent protective devices.

3.5 NFPA 70E (ARC FLASH ANALYSIS) STUDY

A. Calculate Arc-Flash Incident Energy (AFIE) levels and flash protection boundary distances.

B. The Arc-Flash Hazard Analysis (AFHA) shall be performed in conjuncture with a short circuit-analysis and time-current coordination analysis.

C. Results of the analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal protective equipment classes and AFIE levels.

D. The analysis shall be performed under worst case Arc-Flash conditions, and the final report shall describe, when applicable, how these conditions differ from the worst case bolted fault conditions.

E. The AFHA shall be performed in compliance with IEEE Standard 1584 (latest edition) the IEEE Guide for Performing Arc-Flash Calculations.
F. The proposed vendor shall demonstrate experience with AFHA by submitting names of at least ten (10) actual AFHA it has performed in the past year.

G. The proposed vendor shall demonstrate capabilities in providing equipment, services, and training to reduce Arc-Flash exposure and train workers in accordance with NFPA 70E and other applicable standards.

H. The proposed vendor shall demonstrate experience in providing equipment labels in compliance with NEC-2008 section 110 and ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes.

I. Provide study on all major electrical distribution equipment and downstream distribution and utilization equipment. This shall include but not be limited to:
   1. Switchgear
   2. Switchboard
   3. Distribution panelboards
   4. Lighting and appliance panelboards
   5. Disconnect switches
   6. Controller equipment such as variable frequency/adjustable drives
   7. Fuses and circuit breakers
   8. Rotating equipment
   9. Automatic and non-automatic transfer switches
   10. Feeders

J. Provide proper labeling per NFPA 70E on all noted equipment, including any hinged doors or rear accessible equipment. Coordinate study and labeling requirements with PSU Engineering Services. Typical minimum label requirements shown below.
K. Labels shall be orange and include date of study. Specify second blue label to note arc-reduction levels. Refer to Division 26 Section “Overcurrent Protective Device Coordination Study”.

L. Manufacturer representative shall provide a letter stating they have visited the site and confirmed that the stickers have been applied in appropriate locations, per the approved Power System Study.
SECTION 26 08 00 - ELECTRICAL SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Systems and equipment Start-Up and Functional Performance Testing.

B. Validation of proper and thorough installation of Division 26 systems and equipment.

C. Generic Start-Up Documentation for electrical systems and equipment.

D. Development of final Start-Up Documentation for electrical systems and equipment.

E. System Start-Up and Turn-Over procedures.

F. Coordination and execution of Training Events.

1.2 GENERAL DESCRIPTION

A. Commissioning (Cx) is the process of ensuring that (i) all building systems are installed and perform interactively according to the design intent; (ii) that systems are efficient and cost effective and meet the Owner’s operational needs; (iii) that the installation is accurately documented; and (iv) that the Operators are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems, and establishes testing and communication protocols to advance the building systems from installation to optimized, fully-dynamic operation.

B. Commissioning Authority (CxA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.

C. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.

D. This Section outlines the Cx procedures specific to the Division 26 Contractors. Requirements common to all Sections are specified in Sections 01 91 00 and 01 91 10 This Section and other sections of the specification details the Contractor’s responsibilities relative to the Cx process.

1.3 SCOPE

A. The following systems and equipment are included in the Scope of Commissioning for this project:

B. Electrical Systems: All Division 26 equipment and systems are subject to commissioning, including but not limited to the systems listed below. All components and devices that make up these systems are included.

1. Grounding Equipment and Building Grounding System
2. Switchgear/Switchboards
3. Disconnect Switches
4. Circuit Breakers
5. Motor Controllers
6. Distribution Dry-Type Transformers
7. Distribution and Branch Circuit Panelboards
8. Automatic Transfer Switches
9. Feeders and Large Branch Circuits
10. Lighting and Lighting Controls
11. Motors

1.4 RELATED WORK AND DOCUMENTS

A. The Cx process references many related Sections, particularly Section 01 91 00 - General Commissioning. It is important for all Contractors subject to the Cx process to be familiar with Section 01 91 00.

B. Refer to Section 01 91 00 for a complete list of Sections on Related Work.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 01 91 00 for a complete list of Definitions and Abbreviations.

1.6 REFERENCE STANDARDS

A. National Electric Code (NEC)
B. American Society for Testing and Materials (ASTM)
C. Electronics Industry Association/Telecommunications Industry Association (EIA/TIA)
D. Illuminating Engineering Society (IES)
E. Institute of Electrical and Electronics Engineers (IEEE)
F. International Electrical Testing Association (NETA)
G. National Electrical Manufacturers Associates (NEMA)
H. National Fire Protection Association (NFPA)
I. Underwriters Laboratory, Inc. (UL)
J. Refer to Section 01 91 00 for additional Reference Standards.

1.7 DOCUMENTATION

A. Documentation shall be as required in Section 01 91 00. In addition, Contractor shall also provide to the CxA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:
1. Short Circuit and Coordination Study: CxA shall review and recommend approval.
2. Field Testing Agency Reports: Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports should be provided in PDF electronic format. These may include but are not limited to:
   a. Electrical Testing Agency Reports
b. Thermographic Survey Report

1.8 SEQUENCING AND SCHEDULING

A. Refer to Section 01 91 00.

1.9 COORDINATION MANAGEMENT PROTOCOLS

A. Coordination responsibilities and management protocols relative to Cx are initially defined in Section 01 91 00 and the Cx Plan, but shall be refined and documented in the Construction Phase Cx Kick-Off Meeting. Contractor shall have input into the protocols to be used and all Parties will commit to scheduling obligations. The CxA will record and distribute.

1.10 CONTRACTOR RESPONSIBILITIES

A. Refer to Section 01 91 00: Detailed Contractor responsibilities common to all Divisions are specified in Section 01 91 00. The following are additional responsibilities or notable responsibilities specific to Division 26.

B. Construction Phase
   1. Provide skilled technicians qualified to perform the work required.
   2. Provide factory-trained and authorized technicians where required by the Contract Documents.
   3. Prepare and submit required draft Start-Up Documentation and submit along with the manufacturer’s application, installation and start-up information.
   4. Provide assistance to the CxA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review FPT procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.
   5. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this Section.
   6. Start-Up, Adjust, Test, and Turn-Over systems and equipment prior to functional performance testing by the CxA. Approved Start-Up Documentation shall be in accordance with Contract Documents, reference or industry standards, and specifically elsewhere in Part I of this Section.
   7. Record Start-Up on approved Start-Up Documentation forms and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above and in Section 01 09 00. Each task or item shall be indicated with the Party actually performing the task or procedure.
   8. Coordinate the work of the Electrical Testing Agency and the Cx requirements.

C. Acceptance Phase
   1. Assist CxA in Functional Performance Testing. Assistance will typically include the following:
      a. Manipulate systems and equipment to facilitate Functional Performance Testing (as specified in Section 01 91 00, Section 01 91 10, and the Cx Plan; in some cases this will entail only an initial sample);
      b. Provide any specialized instrumentation necessary for Functional Performance Testing;
1.11 EQUIPMENT SUPPLIER RESPONSIBILITIES
   A. Refer to Section 01 91 00.

1.12 CONTRACTOR NOTIFICATION AND SCHEDULING
   A. Refer to Section 01 91 00.

1.13 START-UP DOCUMENTATION
   A. Refer to Section 01 91 00.

1.14 EQUIPMENT NAMEPLATE DATA
   A. Refer to Section 01 91 00.

1.15 INDEPENDENT ELECTRICAL TESTING AGENCY
   A. An Independent Electrical Testing Agency shall be provided under the construction specifications and therefore included with the bid. Many of the aspects of the Start-Up and Functional Performance Testing indicated herein will be accomplished under the respective section and witnessed by the CxA at the indicated sample rate. CxA will include applicable test results in the functional performance testing record.

1.16 FUNCTIONAL PERFORMANCE TESTING
   A. For applicable systems and equipment, Contractor shall participate in the initial samples of Functional Performance Testing as stipulated in Section 01 91 00 and Section 01 91 10.

1.17 FPT ACCEPTANCE CRITERIA
   A. Acceptance criteria for tests are indicated in Section 01 91 10 and in the specification Sections applicable to the systems being tested. Unless indicated otherwise, the criteria for acceptance will be that specified with the individual system, equipment, component, or device, which shall typically conform to NFPA 70B and International Electrical Testing Association (NETA) testing specifications NETA ATS-1991.

1.18 TRAINING
   A. Contractors, subcontractor, vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 01 91 00 and the individual Specifications.

1.19 SYSTEMS MANUAL AND O&M DOCUMENTATION CONTENT - PREPARATION AND LOGISTICS
   A. Refer to Section 01 91 00 the individual Specifications.
PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. Unless otherwise noted, all equipment shall be calibrated according to the manufacturer’s recommended intervals. Calibration tags shall be affixed or certificates readily available.

B. Testing Instrumentation: Contractor shall provide all instrumentation necessary for tests for which they are responsible. CxA will provide standard instrumentation for measuring medium and low voltage electrical voltage, current, power factor, power, and total harmonic distortion (THD). CxA will provide receptacle testers for normal and GFI receptacle tests. Contractor shall provide all other instrumentation required to accomplish the specified testing.

2.2 INFRARED THERMOGRAPHIC SCANNER

A. Contractor shall provide infrared scanning equipment. Infrared scanning equipment shall be an AGA (or approved equal) thermovision set capable of viewing an entire bus or equipment assembly at one time and have a sensitivity of 0.2°C with a liquid nitrogen reference.

2.3 WEB-BASED COMMISSIONING PORTAL

A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal (‘Portal’) to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CxA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.

B. Refer to Section 01 91 00 the individual Specifications for additional information and requirements for using the Portal.

PART 3 - EXECUTION

3.1 GENERIC START-UP DOCUMENTATION - GENERAL

A. Part III of this Section outlines ‘generic’ or minimally acceptable Start-Up Documentation (which are defined to include both ‘Start-Up Checks’ and ‘Start-Up Tests’) and individual systems training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimally acceptable guideline for required Contractor development of Start-Up Documentation. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized final Start-Up Documentation specific to the equipment and systems installed on this project.

B. Section 01 91 00 defines the systems and equipment Start-Up process in detail and provides definitions for Start-Up Documentation, including the generic Start-Up Documentation provided below.
C. Refer to the technical sections of Division 26 for additional Electrical Testing requirements.

3.2 TESTING PROCEDURES

A. Thermographic Scanning
   1. The infrared scan shall be made when the equipment is energized and is operating at its normal capacity, unless otherwise noted. It is intended that the scan be made after the equipment has been in full operation; however, the exact time of conducting the scan will be determined by the CxA near the completion of the project.
   2. Test equipment, miscellaneous tools, and materials shall be transported properly, moved, and set up by trained personnel. Equipment used in testing shall be capable to perform all recommended procedures required by the apparatus and related equipment. All test equipment shall have certification of calibration and be in working order.
   3. All hot spots shall be marked, identified and an infrared thermographic scanning report prepared and furnished to the Owner.
   4. The report shall contain infrared photos of trouble spots with temperature readings.
   5. All sources indicating heat problems shall be promptly reported to the Owner for corrective action by the Division 26 contractor.

B. Grounding Systems
   1. Perform three-point fall-of-potential test per IEEE Standard 81 on the main grounding electrode or system. Resistance shall be no greater than 5 ohms.
   2. Perform the two-point method test per IEEE Standard 81 to determine the ground resistance between the main ground system and all major electrical equipment frames, system neutral, and/or derived neutral points. Resistance shall be no greater than 5 ohms.

3.3 START-UP CHECKS COMMON TO ALL SYSTEMS

A. The following Start-Up verifications and procedures shall be considered common to all systems:
   1. Checkout shall proceed from lower level devices to larger components to the entire system operation.
   2. Verify labeling is affixed per specification and visible.
   3. Verify prerequisite procedures are done.
   4. Inspect for damage and ensure none is present.
   5. Verify system is installed per the manufacturer’s recommendations.
   6. Verify system has undergone Start-Up per the manufacturer’s recommendations.
   7. Verify that access is provided for inspection, operation and repair.
   8. Verify that access is provided for eventual replacement of the equipment.
   9. Verify that record drawings, submittal data and O&M documentation accurately reflect the installed systems.
  10. Verify all gauges and test ports are provided as required by contract documents and manufacturer’s recommendations.
  11. Verify all recorded nameplate data is accurate.
  12. Verify that the installation ensures safe operation and maintenance.
  13. Verify specified replacement material/attic stock has been provided as required by the Contract Documents.
  14. Verify all rotating and moving parts are properly lubricated.
  15. Verify all monitoring and ensure all alarms are active and set per Owner’s requirements.
  16. Complete all nameplate data and confirm that ratings conform to the design documents.
3.4 GROUNDING/BUILDING GROUNDING SYSTEM

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer’s instructions.
   1. Conduct fall of potential ground resistance tests per IEEE Standard 81 at each test well and at service equipment.
   2. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

3.5 SWITCHGEAR/SWITCHBOARDS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: Provide the services of a Factory-Trained Manufacturer’s Representative to assist the Contractor in the installation and start-up service of the equipment for a period of 3 working days in 3 visits and train Owner’s maintenance personnel as specified below. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer’s instructions.
   1. Visual and Mechanical Inspections listed in NETA 7.1.1.
   2. Check calibration/setting of trip devices using system coordination study.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer’s instructions.
   1. Visually and mechanically inspect to include the following: anchoring; grounding; torque of feeder and incoming bus duct connections; feeder cable and integral main bus connections; switchgear section alignments; electrical clearances; mechanical operation of breaker/fuse drawout elements and operating mechanisms, manual trip function; main bus safety shutters; and installation verification using manufacturer's checklist.
   2. Electrical tests listed in NETA 7.1.2. Optional tests are not required.
   3. Test each breaker in accordance with the Circuit Breaker tests listed in this Section.
   4. Conduct operational/functional tests of protective relaying. Time-current tests shall be conducted and trip points shall be set per the Short Circuit and Coordination Study.

E. Training: Train Owner’s maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.6 DISCONNECT SWITCHES

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.
B. General: Refer to the quality control requirements listed in applicable Sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer’s instructions.
   1. Visual and Mechanical Inspections listed in NETA 7.5.1.1.1.
   2. Check installation of warning nameplates and equipment nametags.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer’s instructions.
   1. Electrical tests listed in NETA 7.5.1.1.2.

E. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.7 CIRCUIT BREAKERS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: Provide the services of a manufacturer-certified specialist to supervise the installation, make adjustments, and perform tests on the insulated case breakers, power breakers and medium-voltage breakers and train Owner's maintenance personnel. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer’s instructions.
   1. Visual and Mechanical Inspections listed in NETA 7.6.1.1.1 insulated case and molded case breakers, NETA 7.6.1.2.1 for low-voltage power breakers, and NETA 7.6.1.3.1 for medium-voltage air breakers.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer’s instructions.
   1. Electrical tests listed in NETA 7.6.1.1.2 insulated case and molded case breakers, NETA 7.6.1.2.2 for low-voltage power breakers, and NETA 7.6.1.3.2 for medium-voltage air breakers. Optional tests are not required.

E. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.8 MOTOR CONTROLLERS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer’s instructions.
1. Visual and Mechanical Inspections listed in NETA 7.16.1.1.1, including optional items.
2. Check installation of warning nameplates and equipment nametags.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer’s instructions.
1. Visually and mechanically inspect to include the following: anchoring, grounding, torque of feeder and incoming connections, electrical clearances, starter and feeder unit drawout mechanisms, and check installation using manufacturer’s checklist.
2. Electrical tests listed in NETA 7.16.1.1.2. Optional tests are not required.

E. Training: Train Owner’s maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.9 DISTRIBUTION DRY-TYPE TRANSFORMERS

A. Include all applicable “Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer’s instructions.
   1. Inspect wiring connections.
   2. Insure taps are adjusted.
   3. Inspect grounding.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer’s instructions.
   1. Visually and mechanically inspect to include the following: mounting, grounding, electrical clearances, and K-factor and/or isolating transformers are installed where required.
   2. Perform insulation resistance, turns ratios, and polarity tests on each type/size of transformer.

E. Training: Train Owner’s maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.10 DISTRIBUTION AND BRANCH CIRCUIT PANELBOARDS

A. Include all applicable “Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer’s instructions.
   1. Visually and mechanically inspect to include the following: mounting, separate ground and neutral connections per circuit, completed circuit directories, electrical clearances, KAIC ratings of panelboard and breakers.
   2. Inspect wiring connections.
D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer’s instructions.
   1. Correct surge suppression devices installed.
   2. Conduct insulation resistance tests.
   3. Correct identification and phasing arrangements.
   4. Verify that branch circuit labeling on a minimum of 10% of the panelboard branch circuits matches the printed panelboard directory. If 25% or more of the tested branch circuits do not match the printed directory, verify another 10% of the panelboard branch circuits. If 25%, or more, of these branch circuits do not match the printed directory, verify 100% of the panelboard branch circuits.

3.11 AUTOMATIC TRANSFER SWITCHES (ATS)

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: Provide the services of a manufacturer-certified specialist to supervise the installation, make adjustments, perform tests on the automatic transfer switches, and train Owner's maintenance personnel. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer’s instructions.
   1. Visually inspect the systems.
   2. Ensure the terminations are tight and all ancillary equipment completely installed.
   3. Ensure all overloads are in place.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
   1. Electrical tests listed in NETA 7.22.3.2.

E. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.

3.12 FEEDERS AND LARGE BRANCH CIRCUITS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: This paragraph and subparagraphs apply to all feeders serving panelboards, and motor control centers, all conductors connected to switchgear and switchboards, and all circuits that are rated for 100 amps, or larger. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer’s instructions.
   1. Inspect cable support and terminations.
   2. Verify equipment edges are not in contact with cables or that protective padding is provided.
   3. Visually and mechanically inspect to include the following: large junction and pull boxes, supports of raceways and cable bus, and compression type terminations.
4. Torque test terminations and verify they are in accordance with manufacturers recommendations.
5. Correct identification and phasing arrangements.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer’s instructions.
2. Torque test terminations and verify they are in accordance with manufacturers recommendations.
3. Correct identification and phasing arrangements.
4. Conduct continuity test of each feeder.
5. Conduct insulation resistance test on each cable with respect to ground and adjacent cables.

3.13 LIGHTING CONTROLS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer’s instructions.
1. Ensure all labeling for all relays/contactors is affixed and accurate.
2. Ensure all terminations are tight.
3. Check sensor placement is adequate for required duty.
4. Ensure adequate access is provided to all relays/contactors, timeclocks, etc.
5. Ensure all circuits for the loads are energized and ready for testing.
6. Obtain all time schedules and individual device time-delay settings for all spaces from the Owner.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer’s instructions.
1. Test, calibrate, and set all sensing (photocells, motion sensors, etc.) devices.
2. Verify the correct operation of all control devices (contactors, relays, timeclocks, BAS interface relays, etc.).
3. Check full load current on all breakers serving controlled lighting to ensure that the breaker is properly sized.
4. Check full load current on all control device contacts serving controlled lighting to ensure that the contact rating is properly sized.
5. Enter all time schedules per Owner’s direction. Individual device time-delay settings are handled as part of the Room/Zone Checkout described in this Section.
6. Validate all interfaces with other systems on a point-by-point basis.

E. Training: Train Owner’s maintenance personnel on the operation, programming and maintenance of the lighting controls.

3.14 INTEGRATED LIGHTING CONTROL SYSTEMS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.
B. General: Provide the services of a factory-trained manufacturer's representative to assist the Contractor in the installation and start-up service of the lighting control system and train Owner's maintenance personnel as specified below. Representative will confirm the proper installation and operation of all system components. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.
1. Ensure all labeling is affixed and accurate.
2. Ensure all terminations are tight.
3. Check sensor placement is adequate for required duty.
4. Ensure adequate access is provided to all panels and that documentation of that panel is provided in it.
5. Ensure all circuits for the loads are energized and ready for testing.
6. Obtain all time schedules, individual device time-delay settings for all spaces, and on/off fade-rate settings from the Owner.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.
1. Test, calibrate, and set all digital and analog sensing, and actuating devices. Calibrate each instrumentation device by making a comparison between the graphic display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the Start-Up Report.
2. Check each digital control point by making a comparison between the control command at the control panel and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the OI display. Record the results for each device in the BAS Start-Up Report.
3. Check full load current on all breakers serving controlled lighting to ensure that the breaker is properly sized.
4. Check full load current on all control device contacts serving controlled lighting to ensure that the contact rating is properly sized.
5. Enter all time schedules, override time-delays and on/off fade rates per Owner's direction.
6. For Operator Interfaces:
   a. Verify all elements on the graphics are functional and properly bound to physical devices and/or virtual points and that hot links or page jumps are functional and logical.
   b. Output all specified reports for review and approval.
   c. Verify the alarm printing and logging is functional and per requirements.
7. Validate all interfaces with other systems on a point-by-point basis.

E. Training: Train Owner's maintenance personnel on the operation and programming of the lighting control system. Two days of training will be provided for up to 50 users.

3.15 MOTORS

A. Include all applicable “Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.
B. General: Electrical contractor shall be responsible for ensuring adequate electrical connections for each motor that is directly connected under this project. Where equipment manufacturers provide onsite startup of equipment and perform some, or all, of the required Cx activities for the motors, the Electrical Contractor shall monitor the results of their effort, verify successful completion of the Cx activities and obtain copies of the startup field reports. Refer to the quality control requirements listed in applicable sections of Divisions 22, 23 and 26 for additional checks and tests related to the connection of motors. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks and Tests: Follow the manufacturer's written procedures and the following as a minimum:
1. Inspect terminations and grounding.
2. Ensure proper access to all electrical equipment.
3. Ensure proper labeling of all electrical equipment.
4. Compare wiring of poles to manufacturer's instructions.
5. Check voltage-to-disconnects with disconnect open and compare to rating data.
6. In collaboration with the Contractor who supplied the motor, bump it and ensure proper rotation.
7. Test each motor furnished under Division 26 with megger and record readings. Division 22 and 23 motors will be meggered by the contractors responsible for those divisions. Results of those tests shall be monitored by the Division 26 contractor and verified correct. Ensure that megger test results are documented and a copy is submitted to the commissioning team. Megger test shall be performed at the final disconnect switch/breaker for the motor.
8. For all motors furnished under Division 26, check the overloads in comparison to FLA noted on the motor nameplate and ensure adequacy of protection and reliability. Division 22 and 23 motor overloads will be verified by the contractors responsible for those divisions. Division 26 contractor is responsible for ensuring this has been completed prior to energizing any motors.
9. Observe several starts to ensure the start is reliable.

END OF SECTION 260800
SECTION 26 09 23 - LIGHTING CONTROL DEVICES [C]

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Time switches.
      2. Indoor occupancy sensors.
      3. Lighting contactors.
      4. Emergency shunt relays.
   B. Related Requirements:
      1. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Shop Drawings: Show installation details for occupancy and light-level sensors.
      1. Interconnection diagrams showing field-installed wiring.
      2. Include diagrams for power, signal, and control wiring.
      3. Vendor approved layout of occupancy sensors throughout building.

1.4 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.
PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Invensys Controls.
5. NSi Industries LLC; TORK Products.
6. Tyco Electronics; ALR Brand.

B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Contact Configuration: SPST.
4. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.2 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Building Automation, Inc.
2. Sensor Switch, Inc.
3. Watt Stopper.

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

2.3 EMERGENCY SHUNT RELAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lighting Control and Design; Acuity Lighting Group, Inc.
2. Watt Stopper.
3. Bodine, a Division of Phillips.

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 277 V.

2.4 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 24 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies. Provide vendor approved layout drawing of sensor locations as part of shop drawing package. Vendor may have to modify the layout from the contract documents to meet vendor specific requirements or limitations.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
B. Notify PSU Engineering Services at least 7 days in advance of any testing. A representative of PSU Engineering Services shall witness testing.

C. Perform the following tests and inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safety. Replace damaged and malfunctioning controls and equipment.

D. Lighting control devices will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: Provide on-site assistance in adjusting sensors to suit actual occupied conditions after one month and again after 11 months of occupancy.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner’s operations.

3.7 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Division 26 Section "Network Lighting Controls."

B. Train Owner’s maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23
SECTION 26 09 43 - NETWORK LIGHTING CONTROLS [C]

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes automatically controlled, microprocessor-based, digital lighting controls with integral electrically operated circuit breakers and control module.

B. Related Sections:
   1. Division 26 Section "Lighting Control Devices" for time clocks, photoelectric sensors, occupancy sensors, and multipole contactors.

1.3 DEFINITIONS

A. BACnet: A networking communication protocol that complies with ASHRAE 135.

B. BAS: Building automation system.

C. DALI: Digital addressable lighting interface.

D. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.

F. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

G. PC: Personal computer; sometimes plural as "PCs."

H. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.

I. RS-485: A serial network protocol, similar to RS-232, complying with TIA-485-A.

J. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS

A. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
   1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
   2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

B. Field quality-control reports.

C. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

D. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Electrically Operated, Molded-Case Circuit Breakers: Equal to 5 percent of amount installed for each size indicated, but no fewer than 5 circuit breakers.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

D. Comply with NFPA 70.
1.9 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of compatible components.
   1. Match components and interconnections for optimum performance of lighting control functions.
   2. Coordinate lighting controls with BAS. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
   3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

B. Coordinate lighting control components specified in this Section with components specified in Division 26 Section "Panelboards."

1.10 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure of software input/output to execute switching or dimming commands.
      b. Failure of modular relays to operate under manual or software commands.
      c. Damage of electronic components due to transient voltage surges.
   2. Warranty Period: Two years from date of Substantial Completion.
   3. Extended Warranty Period Failure Due to Transient Voltage Surges: Eight years.

1.11 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of the software.
   1. Provide 30 days’ notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Square D Powerlink 3000C, with Clipsal components and interface.
   2. Watt Stopper DLM
   3. Sensor Switch nLight

2.2 SYSTEM REQUIREMENTS

A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.
B. Performance Requirements: Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to a PC-based network-system control module that processes the signal according to its programming and routes an open or close command to one or more electrically operated circuit breakers in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.

C. Provide web based interface for remote control and monitoring.

2.3 CONTROL MODULE

A. Control Module Description: Panelboard mounted; comply with UL 916 (CSA C22.2, No. 205); microprocessor based, solid-state, 365-day timing and control unit. Control units shall be networked and capable of receiving inputs from sensors and other sources. Panelboard shall use low-voltage-controlled, electrically operated, molded-case branch circuit breakers as prime power-circuit switching devices. Circuit breakers and a limited number of digital or analog, low-voltage control-circuit outputs shall be individually controlled by control module. Line-voltage components and wiring shall be separated from low-voltage components and wiring by barriers. Control module shall be locally programmable. Panelboard shall also comply with Division 26 Section "Panelboards."

1. Display: Single graphic display for programming lighting control panelboards.
2. Interoperability: Control module shall be configured to connect with other control systems using RS-485 network to enable remote workstations to use control module functions.
3. System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90 days' duration.
4. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight saving time and shall provide weekly routine and annual holiday scheduling.
5. Astronomic Control: Automatic adjustment of dawn and dusk switching.
6. Demand Control: Demand shall be monitored through pulses from a remote meter and shall be controlled by programmed switching of loads. System capability shall include sliding window averaging and programming of load priorities and characteristics. Minimum of two different time-of-day demand schedules shall execute load-management control actions by switching output circuits or by transmitting other types of load-control signals.
7. Local Override Capability: Manual, low-voltage control devices shall override programmed shutdown of lighting and shall override other programmed control for intervals that may be duration programmed.
8. Automatic battery backup shall provide power to maintain program and system clock operation for 90 days' minimum duration when power is off.
9. Programmed time signals shall change preset scenes and dimmer settings.
10. Energy Conservation: Bilevel control of special ballasts or dimming circuits to comply with local energy codes.
11. Flick Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.
12. Diagnostics: When system operates improperly, software shall initiate factory-programmed diagnosis of failure and display messages identifying problem and possible causes.

2.4 POWER DISTRIBUTION COMPONENTS

A. Electrically Operated, Molded-Case Circuit-Breaker Panelboard: Comply with NEMA PB 1 and UL 50 (CAN/CSA C22.2, No. 94), UL 67 (CSA C22.2, No. 29), UL 489 (CAN/CSA C22.2, No. 65), and UL 916 (CSA C22.2, No. 205).
1. Cabinets: In addition to requirements specified below, comply with Division 26 Section “Panelboards.”
2. Electrically Operated, Molded-Case Circuit Breakers: Bolt-on type.
   a. Switching Endurance Ratings: Certified by manufacturer or by a nationally recognized testing laboratory (NRTL) for at least 20,000 open and close operations under rated load at 0.8 power factor.
   b. Minimum 30,000 open and close operations with load equal to circuit-breaker trip rating and consisting of 100 percent tungsten filament load.
   c. Minimum 30,000 open and close operations with load equal to circuit-breaker trip rating and consisting of 100 percent fluorescent ballasts rated for 10 percent total harmonic distortion.
   d. Listed and labeled as complying with UL SWD, HCAR, and HID ratings by an NRTL acceptable to authorities having jurisdiction.

B. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels.

2.5 MANUAL ANALOG SWITCHES AND PLATES
   A. Push-Button Switches: Modular, momentary-contact, low-voltage type.
      1. Match color specified in Division 26 Section "Wiring Devices."
      2. Integral green LED pilot light to indicate when circuit is on.
      3. Internal white LED locator light to illuminate when circuit is off.

   B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Division 26 Section "Wiring Devices."

   C. Wall-Box Dimmers: Comply with Division 26 Section "Wiring Devices."

   D. Wall Plates: Single and multigang plates as specified in Division 26 Section "Wiring Devices."

   E. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.6 FIELD-MOUNTED DIGITAL CONTROLS AND PLATES
   A. Connection Type: RS-485 protocol, category 5 UTP cable, using RJ45 connectors. Power shall be from the control unit.

   B. Pushbutton Switches: Modular, solid-state, programmable, digital, momentary contact, designed to connect to a microprocessor based control unit as a manual control source.
      1. Mounting: Standard single-gang recessed switchbox, using device plates specified in Division 26 Section "Wiring Devices."
      2. Multi-Gang Mounting: One to six pushbuttons per gang.

2.7 CONDUCTORS AND CABLES
   A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

   B. Classes 2 and 3 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
C. Class 1 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

D. Structured Network Digital and Multiplexed Signal Cables: UTP cable with copper conductors, complying with TIA/EIA-568-B.2, Category 6 for horizontal copper cable and with Division 27 Section "Communications Horizontal Cabling."

E. RS-485 Cables:
1. Standard Cable: NFPA 70, Type CM.
   a. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
   b. PVC insulation.
   c. Unshielded.
   d. PVC jacket.
   e. Flame Resistance: Comply with UL 1581.

2. Plenum-Rated Cable: NFPA 70, Type CMP.
   a. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
   b. Fluorinated ethylene propylene insulation.
   c. Unshielded.
   d. Fluorinated ethylene propylene jacket.
   e. Flame Resistance: NFPA 262, Flame Test.

F. RS-485 Cables:
1. Standard Cable: NFPA 70, Type CM.
   a. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
   b. PVC insulation.
   c. Unshielded.
   d. PVC jacket.
   e. Flame Resistance: Comply with UL 1581.

2. Plenum-Rated Cable: NFPA 70, Type CMP.
   a. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
   b. Fluorinated ethylene propylene insulation.
   c. Unshielded.
   d. Fluorinated ethylene propylene jacket.
   e. Flame Resistance: NFPA 262, Flame Test.

2.8 SYSTEM COMPUTER

A. Provide (1) laptop computer workstation to interface with lighting control system.

B. Workstation shall be pre-configured with all software and actual job configuration files. Workstation shall be ready to connect and operate when turned on to PSU Engineering Services.

C. System Requirements:
1. Tablet type, Dell Latitude XT2 or similar with 4GB DDR3 SDRAM, 160GB hard drive, DVDRW/DVD, 6-cell battery, separate 9-cell "battery slice", (2) AC adaptors, wireless a/g/n LAN card, Energy Star 5.0, docking station, cordless optical mouse, Windows 7 OS (with XP mode), MS Office 2010 software and backpack case.

2. Provide software and other options as suggested or required to interface with Lighting Control System.

3. Load complete PDF set of all trades as-built drawings and electrical shop drawings onto hard drive and provide BlueBeam PDF reader software.
PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install wiring in raceways. Minimum conduit size shall be 1/2 inch.
1. For power wiring comply with Division 26 Section “Low-Voltage Electrical Power Conductors and Cables”
2. For digital data transmission and low-voltage (operating at less than 50 V) remote control and signaling cables, comply with Division 26 Section "Control-Voltage Electrical Power Cables"

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

D. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

E. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.

G. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Refer to Division 26 Section “Electrical Systems General Provisions” for testing requirements.

B. In addition to Refer to Division 26 Section “Electrical Systems General Provisions”, Provide the following tests and Inspections:
1. Test for circuit continuity.
2. Verify that the control module features are operational.
3. Check operation of local override controls.
4. Test system diagnostics by simulating improper operation of several components selected by Architect.
5. Provide (3) days of onsite manufacturer programming assistance.

C. Lighting controls will be considered defective if they do not pass tests and inspections.

3.3 SOFTWARE INSTALLATION

A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.
3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting controls and software training for PC-based control systems. See Division 01 Section “Demonstration and Training.”

END OF SECTION 26 09 43
SECTION 26 12 00 - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following types of transformers with medium-voltage primaries:
   1. Dry-type distribution and power transformers.

1.3 DEFINITIONS

1.4 ACTION SUBMITTALS
A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For transformer and accessories to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C2.

E. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Store transformers protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer’s written instructions.

1.8 COORDINATION
A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Electric Corporation; Power Distribution Products Division.
2. Cooper Industries; Cooper Power Systems Division.
5. Square D; Schneider Electric.
6. Virginia Transformer Corp.

2.2 DRY-TYPE DISTRIBUTION AND POWER TRANSFORMERS
A. Description: NEMA ST 20, IEEE C57.12.01, ANSI C57.12.50, UL 1562 listed and labeled, dry-type, 2-winding transformers.

1. Indoor, ventilated, cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 185 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.

B. Primary Connection: Transition terminal compartment with connection pattern to match switchgear.

C. Secondary Connection: Transition terminal compartment with connection pattern to match switchgear.

D. Insulation Materials: IEEE C57.12.01, rated at 220 deg C.

E. Insulation Temperature Rise: 150 deg C, maximum rise above 40 deg C.

F. Basic Impulse Level: 60 kV.
G. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.

H. Sound level may not exceed sound levels listed in NEMA TR 1, without fans operating.

I. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

2.3 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to ANSI C57.12.50.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.

B. Examine roughing-in of conduits and grounding systems to verify the following:
   1. Wiring entries comply with layout requirements.
   2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install transformers on concrete bases.
   1. Anchor transformers to concrete bases according to manufacturer's written instructions and requirements in Division 26 Section "Hangers and Supports for Electrical Systems."
   2. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit and 4 inches high.
3. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."
4. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
5. Install epoxy-coated anchor bolts, for supported equipment, that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Tack-weld or bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.

B. Provide a minimum of 2/0 AWG bare copper ground ring with at least (2) 96” ground rods around transformer foundation/pad. Exothermically weld rods and ring. Ring shall be a minimum of 24” from the edge of the foundation/pad, buried 18” and 24” deep. Rods shall be installed at opposite corners or at a distance no more than a rod length apart. Extend cabling a minimum of 48” above grade for connection to transformer. Do not connect this ground ring to building service.

C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION
A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS
A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. Notify PSU Engineering Services at least 7 days in advance of any testing. A representative of PSU Engineering Services shall witness testing.

C. Perform the following field tests and inspections and prepare test reports:
   1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
   2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
   3. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Test Reports: Prepare written reports to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: If requested by Owner, perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.

2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:
   a. Adjust transformer taps.
   b. Prepare written request for voltage adjustment by electric utility.

3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.


B. Infrared Scanning: Perform as specified in Division 26 Section "Medium-Voltage Switchgear."

END OF SECTION 26 12 00
SECTION 26 13 00 - MEDIUM-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes metal-enclosed interrupter switchgear with the following optional components, features, and accessories:

1. Copper, tin-plated main bus.
2. Surge arresters.

1.3 DEFINITIONS


1.4 SUBMITTALS

A. Product Data: For each type of switchgear and related equipment, include the following:

1. Rated capacities, operating characteristics, furnished specialties, and accessories for individual interrupter switches.
2. Time-current characteristic curves for overcurrent protective devices, including fusible devices.

B. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where piping and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Identify field measurements.

C. Qualification Data: For testing agency.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For switchgear and switchgear components to include in operation and maintenance manuals. In addition to items specified in Division 01 Section “Operation and Maintenance Data,” include the following:

1. Time-current curves for each type of overcurrent protective device.
1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain each type of switchgear and associated components through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C2.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections of lengths that can be moved past obstructions in delivery path as indicated.

B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:

1. Ambient temperature not exceeding 122 deg F.

B. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.
1.8 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Three power fuses, stored within the switchgear.
2. Touchup Paint: Three containers of paint matching enclosure finish, each 0.5 pint.

B. Maintenance Tools: Furnish tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include the following:

1. Fuse-handling tool.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Description: Factory assembled and tested, and complying with IEEE C37.20.1.

B. Ratings: Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system.

C. System Voltage: 4.16 kV nominal; 4.76 kV maximum.

2.2 METAL-ENCLOSED INTERRUPTER SWITCHGEAR

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D MiniBreak Load Interrupter Switch or comparable product by one of the following:

1. Eaton Corporation; Cutler-Hammer Products.

B. Comply with IEEE C37.20.3.

C. Comply with IEEE C37.20.7. Provide arc-resistant switchgear, Type 1.


E. Interrupter Switches: Stationary, gang operated, and suitable for application at maximum short-circuit rating of integrated switchgear assembly.

1. Rating: 200-A continuous duty and load break.
2. Duty-Cycle, Fault Closing: 20,000 asymmetrical A.
3. **Switch Action:** No external arc and no significant quantities of ionized gas released into the enclosure.

4. **Switch Construction:** Supported entirely by interior framework of structure, with copper switchblades and stored-energy operating mechanism.

5. **Phase Barriers:** Full length of switchblades and fuses for each pole; designed for easy removal; allow visual inspection of switch components if barrier is in place.

6. **Protective Shields:** Cover live components and terminals.

7. **Fuses:** De-energized if switch is open.

F. **Mechanical Interlock:** Prevent opening switch compartment door unless switchblades are open, and prevent closing switch if door is open.

G. **Window:** Permit viewing switchblade positions if door is closed.

H. **Power Fuses:** Comply with the following and with applicable requirements in NEMA SG 2:
   1. **Indicator:** Integral with each fuse to indicate when it has blown.
   2. **Mounting:** Positively held in position with provision for easy removal and replacement from front without special tools.
   3. **Current-Limiting Fuses:** Full-range, fast-replaceable, current-limiting type that will operate without explosive noise or expulsion of gas, vapor, or foreign matter from tube.

### 2.3 FABRICATION

A. **Indoor Enclosure:** Steel.

B. **Finish:** Manufacturer's standard gray finish over rust-inhibiting primer on phosphatizing-treated metal surfaces.

C. **Incoming-Line Unit:** Arranged to suit incoming line.

D. **Outgoing Feeder Units:** Arranged to suit distribution feeders.

### 2.4 COMPONENTS

A. **Main Bus:** Copper, tin plated.

B. **Ground Bus:** Copper, silver plated or copper, tin plated; minimum size 1/4 by 2 inches; full length of switchgear.

C. **Bus Insulation:** Covered with flame-retardant insulation.

D. **Surge Arresters:** Distribution class, metal-oxide-varistor type. Comply with NEMA LA 1.
   1. Install in cable termination compartments in each phase of circuit.
   2. Coordinate rating with circuit voltage.

### 2.5 IDENTIFICATION

A. **Materials:** Refer to Division 26 Section "Identification for Electrical Systems." Identify units, devices, controls, and wiring.
2.6 SOURCE QUALITY CONTROL

A. Before shipment of equipment, perform the following tests and prepare test reports:
   1. Production tests on circuit breakers according to ANSI C37.09.
   2. Production tests on completed switchgear assembly according to IEEE C37.20.2.

B. Prepare equipment for shipment.
   1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
   2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

2.7 FACTORY FINISHES

A. Finish: Manufacturer's standard color finish applied to equipment before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive switchgear for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Anchor switchgear assembly to 4-inch, channel-iron sill embedded in concrete base and attach by bolting.
   1. Sills: Select to suit switchgear; level and grout flush into concrete base.
   2. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no less than 3 inches in all directions beyond the maximum dimensions of switchgear, unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchgear units and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Diagram and Instructions:
   1. Frame under clear acrylic plastic on front of switchgear.
a. Operating Instructions: Printed basic instructions for switchgear.
b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.

2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

3.4 CONNECTIONS

A. Cable terminations at switchgear are specified in Division 26 Section "Medium-Voltage Cables."
B. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.
C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
D. Connect wiring according to Division 26 Sections "Low-Voltage Electrical Power Conductors and Cables" and "Medium-Voltage Cables."

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.
B. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
C. Notify PSU Engineering Services at least 7 days in advance of any testing. A representative of PSU Engineering Services shall witness testing.
D. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:
      a. Load Interrupter Switchgear.
      b. Surge arresters.
E. Remove and replace malfunctioning units and retest as specified above.
F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.
   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
   2. Instrument: Use an infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes infrared-scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 13 00
SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.


1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Source quality-control test reports.

C. Field quality-control test reports.

D. Efficiency and harmonic testing reports per PSU Engineering Services requirements consisting of the following:

1. No load and full load losses per NEMA ST20.
2. Linear load efficiency data at 1/6 load.
3. Linear Load efficiency data at ¼, ½, ¾, and full load.
4. Linear load efficiency at 35% loading tested per NEMA TP-2.
5. Efficiency under K7 load profile at 15%, 25%, 50% 75%, and 100% of nameplate rating.
1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.7 DELIVERY, STORAGE, AND HANDLING
A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.8 COORDINATION
A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Base Bid:
   1. Base bid is for CSL3 efficiency.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Powersmith "E-Saver-C3"
      b. Eaton Electrical Inc.; Cutler-Hammer Products “HMT"
      c. Mirus International Inc “Ultra"
B. Alternate Bid:
   1. Alternate bid is for TP-1 efficiency.
   2. Manufacturers: Provide transformer by same manufacturer as switchgear.

C. Manufacturers wishing to have products evaluated for acceptability and conformance with the performance requirements of this specification shall provide detailed compliance and/or exception statements, along with documentation identified in Part 1 and test documentation, signed by an engineer, that confirms that the transformer(s) meet the no load losses and efficiency levels identified in Part 2. Failure to provide the required documentation no less that 14 days prior to bid date with disqualify products from consideration for this project.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.
   1. Internal Coil Connections: Brazed or pressure type.
   2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 2.
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Transformer Enclosure Finish: Comply with NEMA 250.
   1. Finish Color: Gray.

E. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.

F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

I. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with CSL3, Class 1 efficiency levels for Base Bid.
   2. Complying with NEMA TP 1, Class 1 efficiency levels for Alternate Bid.
   3. Tested according to NEMA TP 2.
J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.

K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:
   a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
   b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
   c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

L. Wall Brackets: Manufacturer's standard brackets.

M. Fungus Proofing: Permanent fungicidal treatment for coil and core.

N. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

O. Base bid shall be high efficiency copper wound transformers meeting US Department of Energy proposed Candidate Standard Level (CSL) 3 efficiency with extreme no load losses.

1. Maximum no load losses shall not exceed:
   a. 15KVA: 60W.
   b. 30KVA: 99W.
   c. 45KVA: 130W.
   d. 75KVA: 180W.
   e. 112.5KVA: 260W.
   f. 150KVA: 330W.
   g. 225KVA: 450W.
   h. 300KVA: 560W.
   i. 500KVA: 850W.
   j. 750KVA: 1200W.

2. Efficiency at 1/6 load shall meet or exceed:
   a. 15KVA: 96.6%.
   b. 30KVA: 97.4%.
   c. 45KVA: 97.7%.
   d. 75KVA: 98.2%.
   e. 112.5KVA: 98.4.
   f. 150KVA: 98.5%.
   g. 225KVA: 98.5%.
   h. 300KVA: 98.6%.
i. 500KVA: 98.7%

j. 750KVA: 98.7%

P. Deduct alternate bid shall be for copper wound, 115 deg C rise, K-4 rated standard TP-1 transformers.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements in Division 26 Section "Hangers and Supports for Electrical Systems."
3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Refer to Division 26 Section “Electrical Systems General Provisions” for testing requirements.

B. Provide on-site revenue class efficiency and harmonic measurements of transformers once installed and operating. Data shall be collected from the primary and secondary sides of the transformer simultaneously on a synchronized cycle by cycle basis. The use of two discrete meters is not acceptable. Primary and secondary readings shall be synchronized to ensure accuracy. A performance report shall be issued by a licensed engineer.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 22 00
SECTION 26 2300 - LOW-VOLTAGE SWITCHGEAR [C]

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes metal-enclosed, low-voltage power circuit-breaker switchgear rated 1000 V and less for use in ac systems.
B. Related Sections include the following:
   1. Division 26 Section "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
C. Switchgear shall include Arc Flash Reduction system.

1.3 DEFINITIONS
B. GFCI: Ground-fault circuit interrupter.

1.4 ACTION SUBMITTALS
A. Shop Drawings: For each type of switchgear and related equipment.
   1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:
      a. Tabulation of installed devices with features and ratings.
      b. Enclosure types and details.
      c. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
      d. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
      e. Current rating of buses.
      f. Short-time and short-circuit current rating of switchgear assembly.
      g. Nameplate legends.
      h. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   2. Wiring Diagrams: Power, signal, and control wiring.
B. Manufacturer’s engineering power studies shall be submitted to PSU Engineering Services prior to receiving final approval of shop drawings and prior to release of equipment. Refer to Division 26 Section “Overcurrent Protective Device Coordination Study.”

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Six of each type and rating used. Include spares for potential transformer fuses, control power fuses, and fuses and fusible devices for fused circuit breakers.
2. Indicating Lights: Six of each type installed.
3. Touchup Paint: 3 containers of paint matching enclosure finish, each 0.5 pint.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain switchgear through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70.

F. Switchgear shall comply with ANSI C37/UL1558.

G. Circuit breakers shall comply with UL1066.
1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchgear in sections of lengths that can be moved past obstructions in delivery path.

B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

1.9 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.

B. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 40 deg C.
2. Altitude: Not exceeding 6600 feet.

1.10 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction that penetrates ceilings or is supported by them, including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. General Electric Company.
4. Square D; Schneider Electric.

2.2 RATINGS

A. Nominal System Voltage: 480/277 V, 4 wire, 60 Hz.

B. Main-Bus Continuous Ampacity: as indicated on drawings.
C. Short-Time and Short-Circuit Current: Match rating of highest-rated circuit breaker in switchgear assembly.

D. Power distribution equipment manufacturer shall carry in their bid to the electrical contractor a sufficient allowance to provide modifications to equipment, if necessary, based on the results of the engineering power studies. Refer to Section 260573 “Electrical Protective Device Coordination Study.

2.3 FABRICATION

A. Factory assembled and tested and complying with IEEE C37.20.1. Provide the following features:
   1. Vertical barrier between adjacent upright sections.
   2. Safety shutters.

B. Indoor Enclosure Material: Steel.

C. Finish: IEEE C37.20.1, manufacturer’s standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.

D. Circuit-breaker compartments shall be equipped to house drawout-type circuit breakers and shall be fitted with hinged outer doors.

E. Fabricate enclosure with removable, hinged, front and rear doors. Rear doors shall have hasp for padlock. Label rear doors to match front.

F. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:
   1. Bus transition sections.
   2. Incoming-line pull sections.
   3. Hinged front panels for access to metering, accessory, and blank compartments.
   4. Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and side covers and ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.
      a. Set pull box back from front to clear circuit-breaker lifting mechanism.
      b. Bottom: Insulating, fire-resistant material with separate holes for cable drops into switchgear.
      c. Cable Supports: Arranged to ease cabling and adequate to support cables indicated, including those for future installation.

G. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.
   1. Main Phase Bus: Uniform capacity the entire length of assembly.
   3. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
   5. Use copper for connecting circuit-breaker line to copper bus.
6. **Ground Bus:** Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 1/4 by 2 inches.

7. **Supports and Bracing for Buses:** Adequate strength for indicated short-circuit currents.

8. **Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors.** Neutral-bus extensions for busway feeders are braced.

9. **Neutral Disconnect Link:** Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.

10. **Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.**

### 2.4 COMPONENTS

**A. Multifunction Digital-Metering Monitor (DMM) will be provided by PSU Utility Services.** Coordinate all requirements between PSU and manufacturer for complete installation of DMM. Provide provisions for the DMM within an isolated compartment. Compartment shall include CTs on a shorting block and voltage connection brought to a fuse block with disconnect (mount CTs and voltage connection ahead of main). Compartment shall accept a Square D monitor style meter.

**B. Transient Voltage Surge Suppressor:** integral to switchgear, mounted in a separate, barriered compartment, connected to bus with a circuit breaker, sized per manufacturer recommendations. Refer to Division 26 section for TVSS requirements.

**C. Provision for Future Devices:** Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.

**D. Control Power Supply:** Control power transformer supplying 120-V control circuits through secondary disconnect devices. Include the following features:

1. **Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.**
2. **Control Power Fuses:** Primary and secondary fuses with current-limiting and overload protection.
3. **Fuses are specified in Division 26 Section "Fuses."**

**E. Control Wiring:** Factory installed, complete with bundling, lacing, and protection; and complying with the following:

1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
2. Conductors sized according to NFPA 70 for duty required.

### 2.5 CIRCUIT BREAKERS

**A. Description:** Low voltage power circuit breakers, comply with IEEE C37.13.

**B. Ratings:** As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.

**C. Operating Mechanism:** Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
1. Normal Closing Speed: Independent of both control and operator.
2. Slow Closing Speed: Optional with operator for inspection and adjustment.
4. Operation counter.

D. Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:

1. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
2. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
3. Field-adjustable, time-current characteristics.
4. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
5. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
7. Pickup Points: Five minimum, for instantaneous-trip functions.
8. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:
   a. Three-wire circuit or system.
   b. Four-wire circuit or system.
9. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
10. Arc Flash Reduction: Provide arc flash reduction system that shall adjust the trip curve of the breaker relay. Systems utilizing “zone-interlock” exclusively are not acceptable. Arc flash light/current sensing equipment similar to ABB REA Arc Protection System shall be acceptable as approved by Engineer and PSU Engineering Services.
   a. The Arc Flash Reduction Maintenance Switch shall reduce the trip system instantaneous pickup value when enabled. The device must not compromise phase protection or defeat its functionality, even when enabled. Once disabled, the recalibration of phase protection must not be required.
   b. Activation and deactivation of reduced maintenance trip setting shall be accomplished without opening the circuit breaker door and exposing operator to energized parts.
   c. The Arc Flash reduction system shall include a blue LED indicating light for visual indication that the Arc Flash reduction system is activated. Blue LED shall be mounted on the front of each circuit breaker cubicle. The light control voltage shall be a 120 volt AC source separately derived within the switchgear.
   d. Arc reduction maintenance system shall have remote lockable switch on the front of each breaker cubicle to initiate this maintenance setting. The switch must be rated and tested for milli-volt signals in harsh environments. The switch shall include an extra NO/NC contact for remote indication.
   e. The reduced maintenance trip setting must be adjustable with a minimum of five settings ranging from 2.5X to 10X of sensor tap value.
   f. The Arc Flash Reduction System maximum clearing time must not exceed 0.05 seconds. The System must meet the requirements of ANSI C37.59 and EMI testing.
E. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.

F. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:

1. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
2. Circuit-Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open. Status for connection devices for different positions includes the following:
   a. Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
   b. Disconnected Position: Primary and secondary devices and ground contact disengaged.

G. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.

H. Operating Handle: One for each circuit breaker capable of manual operation.

I. Electric Close Button: One for each electrically operated circuit breaker.

J. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.

K. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.

L. Undervoltage Trip Devices: Adjustable time-delay and pickup voltage.

M. Shunt-Trip Devices: Where indicated.

N. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

2.6 ACCESSORIES

A. Accessory Set: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.

1. Racking handle to manually move circuit breaker between connected and disconnected positions.
2. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
B. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.

C. Storage cabinet, with padlock and hasp, for storing equipment and breakers. Unit shall be 60”H x 24”D x 36”W, capable of 900lb/shelf built by Duram, Lyon, Stronghold or approved equal.

D. Floor mount rolling hydraulic foot pump platform lift, Beech Engineering (Division of Miller Products Inc.) Model # PS-2460, or approved equal by Genie, Vestil or Wesco. 72” overall height, rated load of 1000lbs, minimum lift height of 60”, and platform measuring 20”x20”.

E. Padlocking Provisions: Provide Best #11B772-L with core #1C7F1-626 in the following quantities:
   1. One (1) for each rear hinged section.
   2. One (1) for each draw-out circuit breaker cubicle and cubicle space.
   3. Two (2) spare.

F. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

G. Provide set of “as-built” drawings stored in main electrical room. Storage shall be PVC tube mounted on wall with caps on each end. Label tube appropriately.

H. Provide 30”x42” laminated copy of the single line diagram adjacent to the service entrance equipment. Mount in aluminum frame under plexi-glass.

2.7 IDENTIFICATION

A. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:
   1. Frame size of each circuit breaker.
   2. Trip rating for each circuit breaker.
   3. Conduit and wire size for each feeder.

B. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
   1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
   3. Color: Contrasting with factory-finish background; Normal power shall be in white, emergency power in red.

C. Provide nameplate on front and rear of each upright section switchgear.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces where switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance.

   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with applicable portions of NECA 400.

B. Anchor switchgear assembly to 4-inch, channel-iron floor sill embedded in concrete base and attach by bolting.

   1. Sills: Select to suit switchgear; level and grout flush into concrete base.
   2. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 3 inches in all directions beyond the maximum dimensions of switchgear unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Diagram and Instructions:

   1. Frame and mount under clear acrylic plastic on the front of switchgear.

      a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
      b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.

   2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
3.5 FIELD QUALITY CONTROL

A. Refer to Division 26 Section “Electrical Systems General Provisions” for testing requirements.

B. In addition to testing specified in Division 26 Section “Electrical Systems General Provisions”, provide the following tests:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

3.6 ADJUSTING

A. Independent testing agency to set field-adjustable, protective-relay trip characteristics according to results in Division 26 Section "Overcurrent Protective Device Coordination Study."

B. Set field-adjustable, protective-relay trip characteristics.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear. Provide a minimum of eight hours. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 2300
SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Disconnecting and overcurrent protective devices.
3. Accessory components and features.
4. Identification.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers’ technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Include selectable ranges for each type of overcurrent protective device.

C. Manufacturer’s engineering power studies shall be submitted to PSU Engineering Services prior to receiving final approval of shop drawings and prior to release of equipment. Refer to Division 26 Section “Overcurrent Protective Device Coordination Study.”

1.4 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports:
1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in operation and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Include selectable ranges for each type of overcurrent protective device.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Comply with NEMA PB 2.

G. Comply with NFPA 70.

H. Comply with UL 891.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.
C. Handle and prepare switchboards for installation according to NECA 400.

1.8 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding 104 deg F.
   b. Altitude: Not exceeding 6600 feet.

C. Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

1.9 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.11 EXTRA MATERIALS

A. Provide 20% or (2) full sets, whichever is less, spare batteries for electronic trip units.
PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

1. Manufacturers: Same manufacturer as switchgear.

B. Nominal System Voltage: refer to drawings.

C. Main-Bus Continuous Ampacity: refer to drawings.

D. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Drawout, individually mounted.
   2. Branch Devices: Fixed, group mounted.
   3. Sections front and rear aligned.

E. Indoor Enclosures: Steel, NEMA 250, Type 1.

F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

G. Barriers: Between adjacent switchboard sections.

H. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

I. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

J. Removable, Hinged Rear Doors and Compartment Covers: Secured by captive thumb screws, for access to rear interior of switchboard. Provide hasp for padlock.

K. Hinged Front Panels: Allow access to circuit breaker, accessory, and blank compartments.

L. Pull Box on Top of Switchboard:
   1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
   2. Set back from front to clear circuit-breaker removal mechanism.
   3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
   4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
   5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

M. Buses and Connections: Three phase, four wire unless otherwise indicated.
   2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with copper mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
   3. Ground Bus: 1/4-by-2-inch- hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway
feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.

5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.


N. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Main Device: molded-case circuit breaker (MCCB), comply with UL 489, with interrupting capacity to meet available fault currents.

1. Electronic trip circuit breakers with rms sensing, field-replaceable rating plug or field-replaceable electronic trip, integral power supply and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.

2. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, copper, suitable for number, size, trip ratings, and conductor material.

B. Branch Devices: molded-case circuit breakers (MCCB), comply with UL 489, with interrupting capacity to meet available fault currents.


2. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, copper, suitable for number, size, trip ratings, and conductor material.

C. Adjustable magnetic trip type circuit-breaker shall be utilized for frame sizes 100A up to 400A.

D. Electronic trip type for circuit breaker shall be utilized for frame sizes 400A and over. Electronic trip type circuit breakers shall incorporate cause of trip indicator targets. Trip units shall utilize field replaceable batteries.

E. Interrupting rating: all overcurrent protective devices shall be fully rated, series rating is not acceptable.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NECA 400.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NECA 400.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install filler plates in unused spaces of panel-mounted sections.

F. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Refer to Division 26 Section “Electrical Systems General Provisions” for testing requirements.

B. In addition to testing specified in Division 26 Section “Electrical Systems General Provisions”, provide the following tests:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Switchboard will be considered defective if it does not pass tests and inspections.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

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SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   6. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Include selectable ranges for each type of overcurrent protective device.
C. Manufacturer's engineering power studies shall be submitted to PSU Engineering Services prior to receiving final approval of shop drawings and prior to release of equipment. Refer to Division 26 Section “Overcurrent Protective Device Coordination Study.”

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified testing agency.
B. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in operation and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI Type: Two spares for each panelboard.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
B. Handle and prepare panelboards for installation according to NECA 407.

1.9 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
      b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet.

1.10 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Surface-mounted cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door in door cover.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:
   a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

B. Incoming Mains Location: Top and bottom.

C. Phase, Neutral, and Ground Buses:
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.
   2. Main and Neutral Lugs: Mechanical type, copper.
   3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
   4. Feed-Through Lugs: Mechanical type, copper. Locate at opposite end of bus from incoming lugs or main device.
   5. Subfeed (Double) Lugs: Mechanical type, copper. Locate at same end of bus as incoming lugs or main device.
   6. Gutter-Tap Lugs: Mechanical type, copper. Locate at same end of bus as incoming lugs or main device.

E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.


2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Same manufacturer as switchgear.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker.


F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

G. Transient Voltage Surge Suppressor (TVSS): integral to panel where indicated on single line diagram, mounted in a separate, barred compartment, connected to bus with a circuit breaker, sized per manufacturer recommendations. Refer to Division 26 section for TVSS requirements.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Same manufacturer as switchgear.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Group installed panels shall have separate trim.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Same manufacturer as switchgear.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip type for circuit-breaker frame sizes 100A up to 400A. Electronic trip type for circuit breaker frame sizes 400A and over.

2. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   d. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
f. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407.

B. Equipment Mounting: Install panelboards on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Mount top of trim 90 inches above finished floor unless otherwise indicated.

E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
F. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.

G. Install filler plates in unused spaces.

H. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

J. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Directory shall denote source of power. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Notify PSU Engineering Services at least 7 days in advance of any testing. A representative of PSU Engineering Services shall witness testing.

C. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

D. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.

c. Instruments and Equipment:
   1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 2416
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Receptacles, receptacles with integral GFCI, and associated device plates.
      2. Weather-resistant receptacles.
      3. Snap switches and wall-box dimmers.
      4. Communications outlets.
      5. Cord and plug sets.
      6. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS
   A. EMI: Electromagnetic interference.
   B. GFCI: Ground-fault circuit interrupter.
   C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
   D. RFI: Radio-frequency interference.
   E. TVSS: Transient voltage surge suppressor.
   F. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
      2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
C. Samples: One for each type of device and wall plate specified, in each color specified.

1.6 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-
label warnings and instruction manuals that include labeling conditions.

1.8 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective
covering for storage and identified with labels describing contents.
   1. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
   2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets
      installed, but no fewer than two.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers’ Names: Shortened versions (shown in parentheses) of the following
manufacturers' names are used in other Part 2 articles:
   1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
B. Source Limitations: Obtain each type of wiring device and associated wall plate from single
source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS
A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a
qualified testing agency, and marked for intended location and application.
B. Comply with NFPA 70.
C. Devices that are manufactured for use with modular plug-in connectors may be substituted
under the following conditions:
   1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
   2. Devices shall comply with the requirements in this Section.
2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 5351 (single), CR5362 (duplex).
   b. Hubbell; HBL5351 (single), HBL5352 (duplex).
   c. Leviton; 5891 (single), 5352 (duplex).
   d. Pass & Seymour; 5361 (single), 5362 (duplex).

2. Flat screen TV receptacles shall utilize 2-gang recessed combination receptacle and coax outlet by one of the following:
   a. Arlington Industries; Inbox.
   b. Leviton; Recessed Entertainment Box.

2.4 GFCI RECEPTACLES

A. General Description:
   1. Straight blade, feed-through type.
   2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
   3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; VGF20.
   b. Hubbell; GFR5352L.
   c. Pass & Seymour; 2095.
   d. Leviton; 7590.

2.5 CORD AND PLUG SETS

A. Description:
   1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.

2.6 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:

   a. Single Pole:

      1) Cooper; AH1221.
      2) Hubbell; HBL1221.
      3) Leviton; 1221-2.
      4) Pass & Seymour; CSB20AC1.

   b. Two Pole:

      1) Cooper; AH1222.
      2) Hubbell; HBL1222.
      3) Leviton; 1222-2.
      4) Pass & Seymour; CSB20AC2.

   c. Three Way:

      1) Cooper; AH1223.
      2) Hubbell; HBL1223.
      3) Leviton; 1223-2.
      4) Pass & Seymour; CSB20AC3.

   d. Four Way:

      1) Cooper; AH1224.
      2) Hubbell; HBL1224.
      3) Leviton; 1224-2.
      4) Pass & Seymour; CSB20AC4.

C. Pilot-Light Switches, 20 A:

   1. Products: Subject to compliance with requirements, provide one of the following:

      a. Cooper; AH1221PL for 120 and 277 V.
      b. Hubbell; HBL1201PL for 120 and 277 V.
      c. Leviton; 1221-LH1.
      d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.

   2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

2.7 WALL PLATES

   A. Single and combination types shall match corresponding wiring devices.

      1. Plate-Securing Screws: Metal with head color to match plate finish.
      4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

   B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.
2.8 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Round, solid brass with satin finish.

D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for UTP cable complying with requirements in Division 27 Section "Communications Horizontal Cabling."

2.9 POKE-THROUGH ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Pass & Seymour/Legrand.
3. Square D/Schneider Electric.
4. Thomas & Betts Corporation.
5. Wiremold/Legrand.

B. Description:

1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
2. Comply with UL 514 scrub water exclusion requirements.
3. Service-Outlet Assembly: Flush type with four simplex receptacles and space for four RJ-45 jacks complying with requirements in Division 27 Section "Communications Horizontal Cabling."
4. Size: Selected to fit nominal 4-inch cored holes in floor and matched to floor thickness.
5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
6. Closure Plug: Arranged to close unused 4-inch cored openings and reestablish fire rating of floor.
7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, four-pair cables that comply with requirements in Division 27 Section "Communications Horizontal Cabling."

2.10 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.

B. Wall Plate Color: For plastic covers, match device color.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:
   1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
   1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
      c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:
   1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
   4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
   5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
   6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
   7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
   8. Tighten unused terminal screws on the device.
   9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Refer to Division 26 Section “Electrical Systems General Provisions” for testing requirements.

B. In addition to testing specified in Division 26 Section “Electrical Systems General Provisions”, provide the following tests for convenience receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight-blade for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.

D. Wiring device will be considered defective if it does not pass tests and inspections.

END OF SECTION 26 27 26
SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, and enclosed controllers.
2. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
   a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
   b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit on translucent log-log graph paper.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit on translucent log-log graph paper.
4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Comply with NEMA FU 1 for cartridge fuses.
D. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.8 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Edison Fuse, Inc.
   3. Ferraz Shawmut, Inc.
   4. Littelfuse, Inc.
2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch-high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Service Entrance: Class J, time delay.
2. Feeders: Class J, fast acting.
3. Motor Branch Circuits: Class RK1, time delay.
4. Other Branch Circuits: Class RK1, time delay.
5. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
B. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13
SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Shunt trip switches.
4. Molded-case circuit breakers (MCCBs).
5. Molded-case switches.

1.3 DEFINITIONS

A. NC: Normally closed.
B. NO: Normally open.
C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit on translucent log-log graph paper.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.
1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field quality-control reports.
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Manufacturer's field service report.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
   2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit on translucent log-log graph paper.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Fuse Pullers: Two for each size and type.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.
1.9 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.10 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Same manufacturer as switchgear.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Same manufacturer as switchgear.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
4. Hookstick Handle: Allows use of a hookstick to operate the handle.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.
6. Accessory Control Power Voltage: Remote mounted and powered; 24-V dc.

2.3 SHUNT TRIP SWITCHES
A. Manufacturers: Same manufacturer as switchgear.
B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
E. Accessories:
1. Oiltight key switch for key-to-test function.
2. Oiltight green ON pilot light.
3. Isolated neutral lug; 100 percent rating.
4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
5. Form C alarm contacts that change state when switch is tripped.
6. Three-pole, double-throw, fire-safety and alarm relay; 24-V dc coil voltage.
7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.4 MOLDED-CASE CIRCUIT BREAKERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.
B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
   1. Instantaneous trip.
   2. Long- and short-time pickup levels.
   3. Long- and short-time time adjustments.
   4. Ground-fault pickup level, time delay, and i^2t response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.


H. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

I. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
   3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
   4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
   5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
   6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
   7. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
   8. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
   9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
  10. Zone-Selective Interlocking: Integral with ground-fault trip unit; for interlocking ground-fault protection function.
  11. Electrical Operator: Provide remote control for on, off, and reset operations.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
   3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
   4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
D. Install fuses in fusible devices.
E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Refer to Division 26 Section “Electrical Systems General Provisions” for testing requirements.
B. In addition to testing specified in Division 26 Section “Electrical Systems General Provisions”, provide the following tests.
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.
C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

END OF SECTION 26 28 16
SECTION 26 29 13 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:

1. Full-voltage manual.
2. Full-voltage magnetic.
3. Reduced-voltage magnetic.
4. Reduced-voltage solid state.
5. Multispeed.

B. Related Section:

1. Division 26 Section "Variable-Frequency Motor Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on variable torque loads in ranges up to 200 hp.

1.3 DEFINITIONS

A. CPT: Control power transformer.
B. MCCB: Molded-case circuit breaker.
C. MCP: Motor circuit protector.
D. N.C.: Normally closed.
E. N.O.: Normally open.
F. OCPD: Overcurrent protective device.
G. SCR: Silicon-controlled rectifier.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.
1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field quality-control reports.

C. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

D. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and installed components.
2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
3. Manufacturer's written instructions for setting field-adjustable overload relays.
4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

1.7 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.
1.9 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.11 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

1. Manufacturers: Same manufacturer as switchgear.
2. Configuration: Nonreversing.
3. Flush Surface mounting.

C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Manufacturers: Same manufacturer as switchgear.
2. Configuration: Nonreversing.
3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
4. Surface mounting.
5. Green pilot light.

D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
1. Manufacturers: Same manufacturer as switchgear.
2. Configuration: Nonreversing.
3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type.
4. Surface mounting.
5. Green pilot light.
6. N.O. auxiliary contact.

E. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
1. Manufacturers: Same manufacturer as switchgear.
3. MCP Disconnecting Means:
   a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
   b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
   d. N.O. alarm contact that operates only when MCP has tripped.
   e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

2.2 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
1. Dry and Clean Indoor Locations: Type 1.
2. Outdoor Locations: Type 3R.
3. Other Wet or Damp Indoor Locations: Type 4.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.3 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
a. Push Buttons: Recessed types; maintained as indicated.
b. Pilot Lights: LED types; colors as indicated; push to test.
c. Selector Switches: Rotary type.

2. Elapsed Time Meters: Heavy duty with digital readout in hours; resettable.
3. Meters: Panel type, 2-1/2-inch minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.

B. Reversible N.C./N.O. auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.


E. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

F. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in Type 3R enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

H. Cover gaskets for Type 1 enclosures.

I. Terminals for connecting power factor correction capacitors to the load side of overload relays.

J. Spare control wiring terminal blocks, quantity as indicated; unwired.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

D. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

E. Install power factor correction capacitors. Connect to the load side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.

F. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices and facility's central control system. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

   1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
   2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. Refer to Division 26 Section "Electrical Systems General Provisions" for testing requirements.

B. In addition to testing specified in Division 26 Section "Electrical Systems General Provisions", provide the following tests.

   1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.
3. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.

4. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.

5. Test continuity of each circuit.

6. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).

7. Test each motor for proper phase rotation.


9. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

10. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Enclosed controllers will be considered defective if they do not pass tests and inspections.

3.6 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers at 50 percent.

E. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

F. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.
3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage solid-state controllers.

END OF SECTION 26 29 13
SECTION 26 36 00 - TRANSFER SWITCHES [C]

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:
   1. Automatic transfer switches.
   2. Bypass/isolation switches.
   3. Nonautomatic transfer switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Features and operating sequences, both automatic and manual.
   2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing
Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain automatic transfer switches bypass/isolation switches nonautomatic transfer switches and remote annunciator and control panels through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NEMA ICS 1.

F. Comply with NFPA 70.

G. Comply with NFPA 99.

H. Comply with NFPA 110.

I. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide ASCO 4000 Series or comparable product by one of the following:

1. Contactor Transfer Switches:
   a. GE Zenith Controls.
   b. Eaton.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Switching. Where four-pole switches are indicated, provide overlapping neutral contacts.

H. Neutral Terminal: Fully rated, unless otherwise indicated.

I. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

K. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

1. Normal source acceptable, emergency source acceptable and switch status shall be monitored by the building automation system.
2. Transfer switch shall log data and maintain last 99 events upon loss of power. Data logged shall be as follows:
   a. Total number of transfers.
   b. Number of transfers caused by power failures.
   c. Total number of days controller has been energized.
2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.


E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

G. Motor Disconnect and Timing Relay: Controls designated starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.

H. Automatic Transfer-Switch Features:
   1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
   2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
   3. Voltage/Frequency Lockout Relay: Prevent premature transfer to emergency source. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
   4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
   5. Test Switch: Simulate normal-source failure.
   6. Switch-Position Pilot Lights: Indicate source to which load is connected.
      a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
   8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

2.4 NONAUTOMATIC TRANSFER SWITCHES

A. Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." In addition, removable manual handle provides quick-make, quick-break manual-switching action. Switch shall be capable of electrically or manually transferring load in either direction with either or both sources energized. Control circuit disconnects from electrical operator during manual operation.

B. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.

C. Nonautomatic Transfer-Switch Accessories:

1. Pilot Lights: Indicate source to which load is connected.
   a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

3. Unassigned Auxiliary Contacts: One set of normally closed contacts for each switch position, rated 10 A at 240-V ac.

2.5 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details.

B. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

C. Identify components according to Division 26 Section "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Refer to Division 26 Section “Electrical Systems General Provisions” for testing requirements.

B. In addition to testing specified in Division 26 Section “Electrical Systems General Provisions”, provide the following tests:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
   a. Check for electrical continuity of circuits and for short circuits.
   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
   c. Verify that manual transfer warnings are properly placed.
   d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time-delay settings.
   d. Verify pickup and dropout voltages by data readout or inspection of control settings.
   e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
   f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.

5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
   a. Verify grounding connections and locations and ratings of sensors.
C. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 36 00
SECTION 26 43 13 - TRANSIENT-VOLTAGE SUPPRESSION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes field-mounted TVSS for low-voltage (120 to 600 V) power distribution and control equipment.
B. Related Sections:
   1. Division 26 Section "Switchgear" for factory-installed TVSS.
   2. Division 26 Section "Panelboards" for factory-installed TVSS.
   3. Division 26 Section "Wiring Devices" for devices with integral TVSS.

1.3 DEFINITIONS
B. SVR: Suppressed voltage rating.
C. TVSS:Transient voltage surge suppressor(s), both singular and plural; also, transient voltage surge suppression.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.

1.5 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified testing agency.
B. Product Certificates: For TVSS devices, from manufacturer.
C. Field quality-control reports.
D. Warranties: Sample of special warranties.
1.6 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For TVSS devices to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS
   A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      1. Replaceable Protection Modules: One of each size and type installed.

1.8 QUALITY ASSURANCE
   A. Testing Agency Qualifications: Member company of NETA or an NRTL.
      1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
   B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.
   C. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.
   D. Comply with NEMA LS 1.
   E. Comply with UL 1283 and UL 1449.
   F. Comply with NFPA 70.

1.9 PROJECT CONDITIONS
   A. Service Conditions: Rate TVSS devices for continuous operation under the following conditions unless otherwise indicated:
      1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
      2. Operating Temperature: 30 to 120 deg F.
      3. Humidity: 0 to 85 percent, noncondensing.
      4. Altitude: Less than 20,000 feet above sea level.

1.10 COORDINATION
   A. Coordinate location of field-mounted TVSS devices to allow adequate clearances for maintenance.
1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SERVICE ENTRANCE SUPPRESSORS

A. Manufacturers: Same manufacturer as switchgear.

B. Surge Protection Devices:

1. Comply with UL 1449.
2. Modular design (with field-replaceable modules).
3. Fuses, rated at 200-kA interrupting capacity.
4. Fabrication using bolted compression lugs for internal wiring.
5. Integral disconnect switch.
6. Redundant suppression circuits.
7. Redundant replaceable modules.
8. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
9. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
10. LED indicator lights for power and protection status.
11. Audible alarm, with silencing switch, to indicate when protection has failed.
12. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

C. Peak Single-Impulse Surge Current Rating: 120 kA per mode, 240 kA per phase.

D. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2

1. Line to Neutral: 70,000 A.
2. Line to Ground: 70,000 A.
3. Neutral to Ground: 50,000 A.

E. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 V and 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 800 V for 480Y/277 V.
2. Line to Ground: 800 V for 480Y/277 V.

F. Protection modes and UL 1449 SVR for 240/120 V, single-phase, 3-wire circuits shall be as follows:
1. Line to Neutral: 400 V.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

2.2 PANELBOARD SUPPRESSORS

A. Manufacturers: Same manufacturer as switchgear.

B. Surge Protection Devices:
   1. Comply with UL 1449.
   2. Modular design (with field-replaceable modules).
   3. Short-circuit current rating complying with UL 1449, and matching or exceeding the panelboard short-circuit rating and redundant suppression circuits; with individually fused metal-oxide varistors.
   4. Fuses, rated at 200-kA interrupting capacity.
   5. Fabrication using bolted compression lugs for internal wiring.
   6. Integral disconnect switch.
   7. Redundant suppression circuits.
   8. Redundant replaceable modules.
   9. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
   10. LED indicator lights for power and protection status.
   11. Audible alarm, with silencing switch, to indicate when protection has failed.
   12. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

C. Peak Single-Impulse Surge Current Rating: 80 kA per mode, 160 kA per phase.

D. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2:
   1. Line to Neutral: 70,000 A.
   2. Line to Ground: 70,000 A.
   3. Neutral to Ground: 50,000 A.

E. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 V and 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:
   1. Line to Neutral: 800 V for 480Y/277 V, 400 V for 208Y/120 V.
   2. Line to Ground: 800 V for 480Y/277 V, 400 V for 208Y/120 V.
   3. Neutral to Ground: 800 V for 480Y/277 V, 400 V for 208Y/120 V.

F. Protection modes and UL 1449 SVR for 240/120-V, single-phase, 3-wire circuits shall be as follows:
   1. Line to Neutral: 400 V.
   2. Line to Ground: 400 V.
   3. Neutral to Ground: 400 V.
2.3 ENCLOSURES

A. Indoor Enclosures: NEMA 250 Type 1.

B. Outdoor Enclosures: NEMA 250 Type 3R.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install TVSS devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install TVSS devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide multiple circuit breaker as a dedicated disconnecting means for TVSS sized per manufacturer’s recommendations.

3.2 FIELD QUALITY CONTROL

A. Refer to Division 26 Section “Electrical Systems General Provisions” for testing requirements.

B. In addition to testing specified in Division 26 Section “Electrical Systems General Provisions”, provide the following tests:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
2. After installing TVSS devices but before electrical circuitry has been energized, test for compliance with requirements.
3. Complete startup checks according to manufacturer's written instructions.

C. TVSS device will be considered defective if it does not pass tests and inspections.

3.3 STARTUP SERVICE

A. Do not energize or connect service entrance equipment and panelboards to their sources until TVSS devices are installed and connected.

B. Do not perform insulation resistance tests of the distribution wiring equipment with the TVSS installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to maintain TVSS devices.
SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Interior lighting fixtures, lamps, and ballasts.
   2. Emergency lighting units.
   3. Exit signs.
   4. Lighting fixture supports.
   5. Retrofit kits for fluorescent lighting fixtures.

B. Related Sections:
   1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
   2. Division 26 Section "Network Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.3 DEFINITIONS

A. BF: Ballast factor.
B. CCT: Correlated color temperature.
C. CRI: Color-rendering index.
D. HID: High-intensity discharge.
E. LER: Luminaire efficacy rating.
F. Lumen: Measured output of lamp and luminaire, or both.
G. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Ballast, including BF.
   4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
   5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least three of each type.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

D. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.8 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated on Drawings.

B. In addition to the general requirements relating to substitutions as specified in Division 01 "Substitution Procedures", substitutions of lighting fixtures shall comply with the following:
   1. The Design Team, consisting of the Architect, Engineer and Lighting Consultant, shall evaluate all proposed substitutions. The Architect reserves the right to require the use of all specified products unless specific substitutions have been approved by the Architect in writing.
   2. Proposed substitutions shall be of equivalent performance, efficiency, dimensions and quality of construction as specified fixture. It shall be incumbent upon the Contractor to
demonstrate equivalent performance, efficiency, dimensions and quality of construction. The Owner, in conjunction with the Design Team, shall evaluate the proposed substitution against the basis of design.

3. Proposed substitutions that are judged to not be equivalent to the basis of design shall be considered “value engineering” and shall be submitted complete with the reduction of Contract amount that will occur if the substitution is accepted.

4. The professional time to evaluate any such substitution request by the Design Team shall be compensated by the Contractor. Such payment compensation does not guarantee approval.

5. No compensation will be given or made due to rejection of a substituted product not approved in writing.

6. The Contractor shall be fully responsible for modifying all other systems to accommodate the proposed substitution, including but not limited to the impact on the following: lamps, ballasts, controls, supports, branch wiring, LEED requirements, and coordination with mechanical, structural, and architectural elements.

7. The substituted products shall result in a complete and functioning lighting system which operates as designed.

8. All lighting systems and related equipment, lamps, devices, etc. specified herein shall be ordered in sufficient time to complete the project on the schedule established at the time of notice to proceed, or as may be changed thereafter with the Owner’s consent. Substitution requests caused by the inability to obtain specified products shall be forwarded with proof of timely ordering and written proof from the specified manufacturer that despite timely efforts, the specified products cannot be supplied on time. Inadequately documented requests of this type or other late substitution requests will not be considered.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

C. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

G. Diffusers and Globes:
   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic meeting ASTM specifications for methacrylate molding compounds D.788-69A. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
      a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
      b. UV stabilized.
   2. Glass: Annealed crystal glass unless otherwise indicated.
H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp and ballast characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
      c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
      d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
      e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
      f. CCT and CRI for all luminaires.

I. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

J. Provide field applied label on each lighting fixture ballast chamber in 1/8" lettering to read "__V; Instant-Start; _.__ Ballast Factor" or "__V; Program-Start; _.__ Ballast Factor" (insert the voltage and ballast factor in underlined space). For Example, “120V; Program-Start; 0.88 Ballast Factor.”

K. Provide inline disconnect in all lighting fixtures to comply with 2008 NEC 410.13-(G). Provide wire nut connection on load side of disconnect to facilitate ballast replacement.

L. Obtain all similar lamp types through one source from a single manufacturer.

M. Provide 2 year warranty for all lamps.

N. Provide 5 year warranty for all ballasts.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. General Requirements for Electronic Ballasts:
   1. Comply with UL 935 and with ANSI C82.11.
   2. NEMA premium efficiency.
   3. Designed for type and quantity of lamps served.
   4. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
   5. Sound Rating: Class A.
   7. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
   8. Operating Frequency: 42 kHz or higher.
   9. Lamp Current Crest Factor: 1.7 or less.
   10. BF: 0.88 or as listed on the Lighting Fixture Schedule.
   11. Power Factor: 0.95 or higher.
   12. Programmed rapid start ballasts (PRS) utilized with occupancy or in frequent switching scenarios shall be by one of the following unless otherwise noted:
      a. Advance: Optima.
      b. GE: UltraStart.
      c. Sylvania: Prostart.
   13. Instant start ballasts (IS) utilized with manual switching or unswitched fixtures shall be by one of the following unless otherwise noted:
a. Advance: Optanium.
b. GE: Ultramax.
c. Sylvania: QHE.
d. Universal: ULTim8.

B. Luminaires controlled by occupancy sensors shall have programmed rapid start ballasts.

C. Electronic Programmed-Start Ballasts for T5HO Lamps: Comply with ANSI C82.11 and the following:
   1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
   2. Automatic lamp starting after lamp replacement.

D. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.

E. Single Ballasts for Multiple Lighting Fixtures: Factory wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.

F. Ballasts for Low-Temperature Environments:
   1. Temperatures 0 Deg F and Higher: Electronic instant start type rated for 0 deg F starting and operating temperature with indicated lamp types.

G. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.

H. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
   1. Dimming Range: 100 to 5 percent of rated lamp lumens.
   2. Ballast Input Watts: Can be reduced to 20 percent of normal.
   3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
   4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.

I. Ballasts for Tri-Level Controlled Lighting Fixtures: Electronic type.
   1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
      a. High-Level Operation: 100 percent of rated lamp lumens.
      b. Low-Level Operation: 30 and 60 percent of rated lamp lumens.
   2. Ballast shall provide equal current to each lamp in each operating mode.
   3. Compatibility: Certified by manufacturer for use with specific tri-level control system and lamp type indicated.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
   1. Lamp end-of-life detection and shutdown circuit.
   2. Automatic lamp starting after lamp replacement.
   3. Sound Rating: Class A.
   4. Total Harmonic Distortion Rating: Less than 20 percent.
   5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher unless otherwise indicated.
9. Power Factor: 0.95 or higher.
10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.5 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
   1. Lamps for AC Operation: Red LEDs, 50,000 hours minimum rated lamp life.

2.6 FLUORESCENT LAMPS

A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches, 3100 initial lumens (minimum), CRI 80-86, color temperature 3500 K, and average rated life 36,000 hours unless otherwise indicated.
   1. Lamps shall be by one of the following:
      a. GE High Lumen: F32T8/XL/SPX35/HL/ECO
      b. Philips Advantage: F32T8/ADV835/ALTO
      c. Sylvania XPS: F032/835/XPS/ECO

B. T5HO rapid-start, high-output lamps, rated 54 W maximum, nominal length of 45.2 inches, 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 4100 K, and average rated life of 20,000 hours unless otherwise indicated.
   1. Lamps shall be by one of the following:
      a. Phillips: 49W T5HO
      b. Sylvania: 50W T5HO

C. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500 K, average rated life of 16,000 hours at three hours operation per start, and suitable for use with dimming ballasts unless otherwise indicated.
   1. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
   2. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).

2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.


E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures:
   1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
   2. Install lamps in each luminaire.

B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

D. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
   1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.
   2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
   3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
   4. Install at least two independent support rods or wires from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

E. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
   4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

F. All fluorescent lamps on dimming ballasts shall be burned in at full brightness for 100 hours continuously prior to dimming. Bypass local control if necessary.

G. All lighting fixtures shall be thoroughly cleaned and clear of dust, paint and construction debris and fingerprints after all other trades are complete, but prior to date of substantial completion.

H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
3.3 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 26 51 00
SECTION 26 56 00 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Exterior luminaires with lamps and ballasts.
      2. Luminaire-mounted photoelectric relays.
      3. Poles and accessories.
      4. Luminaire lowering devices.
   B. Related Sections:
      1. Division 26 Section “Interior Lighting” for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS
   A. CCT: Correlated color temperature.
   B. CRI: Color-rendering index.
   C. HID: High-intensity discharge.
   D. LER: Luminaire efficacy rating.
   E. Luminaire: Complete lighting fixture, including ballast housing if provided.
   F. Pole: Luminaire support structure, including tower used for large area illumination.
   G. Standard: Same definition as “Pole” above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION
   A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
   B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4-M.
   C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.
D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

1.5 ACTION SUBMITTALS

A. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
   3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
   4. Wiring Diagrams: For power, signal, and control wiring.

B. Samples: For products designated for sample submission in the Exterior Lighting Device Schedule. Each Sample shall include lamps and ballasts.

1.6 INFORMATIONAL SUBMITTALS

A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

B. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: One for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.
   4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.
1.9 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.


D. Comply with NFPA 70.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.

D. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminares: Five years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings.
2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
   1. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp and ballast characteristics:
      a. "USES ONLY" and include specific lamp type.
      b. ANSI ballast type (M98, M57, etc.) for HID luminaires.
      c. CCT and CRI for all luminaires.
2.3 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F.
3. Normal Ambient Operating Temperature: 104 deg F.
4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

2.4 HID LAMPS

A. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65, and CCT color temperature 4000 K.
B. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and CCT color temperature 4000 K.
C. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and CCT color temperature 4000 K.

2.5 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers’ mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws. Provide on all, except wood poles.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
G. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

2.6 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.

B. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.
   1. Shape: Round, tapered.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
   1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
   2. Finish: Same as pole.

F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

G. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
   2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
   3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
   4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.
1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.
3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

   1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
   2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
   3. Install base covers unless otherwise indicated.
   4. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

   1. Dig holes large enough to permit use of tampers in the full depth of hole.
   2. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.

F. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

   1. Make holes 6 inches in diameter larger than pole diameter.
   2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days, and finish in a dome above finished grade.
   3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
   4. Cure concrete a minimum of 72 hours before performing work on pole.

G. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.
H. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

   1. Install grounding electrode for each pole unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

   1. Install grounding electrode for each pole.
   2. Install grounding conductor and conductor protector.
   3. Ground metallic components of pole accessories and foundations.

3.7 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

   1. Verify operation of photoelectric controls.
C. Illumination Tests:
   a. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following University standards.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.8 DEMONSTRATION

A. Train Owner’s maintenance personnel to adjust, operate, and maintain luminaire lowering devices.

END OF SECTION 26 56 00
SECTION 27 05 36 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Wire-basket cable trays.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of cable tray.
   1. Include data indicating dimensions and finishes for each type of cable tray indicated.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design cable tray supports and seismic bracing.
B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS
A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
   1. Source Limitations: Obtain cable trays and components from single manufacturer.
B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 WIRE-BASKET CABLE TRAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Tube & Conduit; a Tyco International Ltd. Co.
2. Cablofil/Legrande.
4. Cooper B-Line, Inc.
5. Enduro Systems, Inc.
7. MP Husky.
8. Niedax-Kleinhuis USA, Inc.
10. Wiremaid Products Division; Vutec Corporation.

B. Description:

1. Configuration: Wires are formed into a standard 2-by-4-inch wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
4. Sizes:
   a. Straight sections shall be furnished in standard 118-inch lengths.
   b. Wire-Basket Depth: 6-inch usable loading depth by 6 inches wide.
5. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.
6. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
7. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.

2.4 MATERIALS AND FINISHES

A. Steel:

1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
2. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.

5. Finish: Hot-dip galvanized after fabrication.

a. Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
b. Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
c. Epoxy-Resin Topcoat: Epoxy, cold-cured, gloss, MPI# 77.
d. Hardware: Chromium-zinc plated, ASTM F 1136.

7. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.
8. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

2.5 CABLE TRAY ACCESSORIES
A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
B. Covers: Louvered type made of same materials and with same finishes as cable tray.
C. Barrier Strips: Same materials and finishes as for cable tray.
D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS
A. Comply with requirements for fasteners in Division 26 Section "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL
A. Testing: Test and inspect cable trays according to NEMA FG 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION
A. Install cable trays according to NEMA FG 1.
B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

F. Fasten cable tray supports to building structure.

G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems."

H. Support bus assembly to prevent twisting from eccentric loading.

I. Support wire-basket cable trays with trapeze hangers.

J. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

K. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1. Space connectors and set gaps according to applicable standard.

L. Make changes in direction and elevation using manufacturer's recommended fittings.

M. Make cable tray connections using manufacturer's recommended fittings.

N. Seal penetrations through fire and smoke barriers. Comply with requirements in Division 07 Section "Penetration Firestopping."

O. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

P. Install cable trays with enough workspace to permit access for installing cables.

Q. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

R. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

S. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."
B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with control conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.

7. Check for improperly sized or installed bonding jumpers.

8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.

9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 27 05 36
SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING [C]

PART 1 - GENERAL CONDITIONS

1.1 CONCURRENT OPERATIONS

Because other activities of the Owner will be proceeding at the same time of the work covered by the specification, the Contractor shall cooperate with the Owner’s Representative to ensure that all contract work progresses in a manner which does not conflict with other activities.

All contractor employees shall conduct themselves in a professional and courteous manner, and shall abide by all applicable University Policies while on University property.

1.2 WORKMANSHIP

All workmen shall be thoroughly experienced in the particular class of work in which they are employed. All materials shall be securely fastened in place in a neat and workmanlike manner.

1.3 CLEAN-UP

Contractor shall be responsible for maintaining all work areas in a neat and orderly manner. Immediately upon completion, all clean up shall be performed to the satisfaction of the Owner’s Representative.

1.4 SAFETY

The Contractor shall comply with all applicable provisions of the Occupational Safety and Health Act (OSHA) throughout the duration of the specified work. The contractor shall be responsible for guarding against fire, and shall provide suitable fire extinguishers conveniently located at the site.

1.5 INSPECTION OF WORK IN PROGRESS AND UPON COMPLETION

Non-compliance with the terms of this specification and ensuing contract can result in either the cancellation of the contract, or complete replacement of the defective areas at the Contractor’s expense. In the event of cancellation, the Owner will not be obligated to compensate the Contractor for any work undertaken. Furthermore, damages caused by water infiltration resulting from the failure of the Contractor to secure each days work in a weather tight manner, will be corrected at the Contractor’s expense.

1.6 CHANGES IN THE WORK

All proposals for additions, deductions, alterations or changes from the specified work shall be submitted to and approved by the Owner in writing.

1.7 SUBSTITUTION OF MATERIALS
A. Whenever a particular make of material is shown or specified herein, such make of material shall be regarded as a standard. Any other make of material will be accepted which is comparably equal to that and suitable for the purpose intended.

B. A bidder intending to furnish an alternate in place of the item specified will be required to submit to the Owner's Representative the following when requested, generally prior to award of contract:

1. A sample of the material which he intends to furnish under the bid and manufacturers literature, "cut sheets" and any applicable technical data. It shall be the bidders responsibility to demonstrate equivalency to the specified product.

2. In order to substantiate the equality of performance of the alternate material under actual field use, a bidder offering "or equal" materials shall also submit a list of at least three (3) jobs with his bid, where the proposed alternate materials have been used under similar conditions as specified within a radius of fifty (50) miles from this location. These jobs must each be at least three (3) years old and must be available for inspection by all persons designated as "Owner Representatives".
   
   a. The Owner reserves the right to be the final authority on the acceptance or rejection of any proposed alternate materials. If the substituted materials are determined to be not equivalent, the bidder shall provide materials as specified or the bid will be rejected
   
   b. Any bidder intending to use alternate materials will be required to write, “ALTERNATIVE” on the proposal sheet submitted, along with a statement noting what "or equal" material has been substituted in place of what specified material.

1.8 ALL BIDDERS SHALL GUARANTEE TO THE OWNER THAT CONTRACTORS TO BE UTILIZED FOR THIS PROJECT SHALL BE ON THE LATEST PRE-QUALIFIED BIDDERS LIST AS RELEASED BY THE PENNSYLVANIA STATE UNIVERSITY.

PART 2 - SECTION 2 - Installation

2.1 DEFINITIONS:

A. Finished space: Including exterior areas, occupied rooms or space visible to the public. All work shall be concealed in finished space.

B. Unfinished space: Room or space accessible only to building maintenance personnel; or specifically shown as “unfinished spaces”

C. Concealed: Used in connection with installation and painting of conduit and accessories; means hidden from sight as in trenches, chases, furred spaces, pipe shafts, ceiling spaces, and hollow walls; and where not hidden from sight in partially excavated or crawl spaces.

D. Exposed: used in connection with installation of conduit and accessories; means not concealed as defined above.

E. Provide: Furnish and install.
2.2 DRAWS NGES ARE DIAGRAMMATIC TO INDICATE GENERAL CHARACTER AND INTENT OF WORK INCLUDED. RIGHT IS RESERVED TO MAKE REASONABLE CHANGES.

2.3 CUTTING, PATCHING AND PAINTING

A. All cutting, patching and painting required in connection with these specifications shall be carried out by or under the direct supervision of the Telecommunications Contractor using mechanics experienced in their line of work. All patching and painting shall match the adjacent finishes.

B. Cutting shall be accomplished in such a manner as not to cause damage to the building or leave unsightly surfaces which cannot be concealed by plates or other construction. Where such unsightly conditions are caused by the Telecommunications Contractor, he shall be required at his own expense to engage a mechanic experienced in this line of work to repair the damaged areas. All holes or openings to be put in existing concrete shall be bored.

2.4 REFERENCES

A. The latest edition of all referenced standards shall apply, unless otherwise noted.


C. TIA/EIA-568B 2.2 – Transmission Performance Specifications for 4-pair 100 ohm Category 6 cabling.

D. EIA/TIA-569 - Commercial Building Standard for Telecommunication Pathways and Spaces.

E. NFPA 70 - National Electrical Code

F. EIA Standards for Test Procedures Fiber Optic.

G. TIA/EIA-607 - Grounding and Bonding Requirements for Telecommunications.


2.5 QUALITY ASSURANCE

A. Perform work in accordance with EIA/TIA Building Telecommunications Wiring Standards, and provisions of this document.

B. Furnish 15 year application assurance and 15 year extended product warranty in writing.

2.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.
B. Furnish products and materials listed and classified by Underwriter's Laboratories, Inc. as suitable for purpose specified and indicated.

2.7 INSTALLATION – TELECOMMUNICATIONS EQUIPMENT

A. Install wire and cable as indicated on the drawings and in accordance with manufacturer instructions and EIA/TIA Building Telecommunications Wiring Standards. “The maximum horizontal distance shall be 90 meters (295 ft.) independent of media type. This cable length is from the mechanical termination of the media in the telecommunications room to the telecommunications outlet.”

B. All Horizontal UTP cable will terminate at the wall plate on a Category 6 jack, T568B, gray. Wire will terminate per TIA/EIA 568A. Note section 10.6.3.1 “connector termination practices”.

C. All Horizontal UTP cable in the Telecommunications room will terminate in a patch panel, located in a 19-inch rack equipped with cable management system. Wire will terminate per TIA/EIA 568A, note section 10.6.3.1 “connector termination practice”.

D. Video cable at the wall plate will terminate with a hex crimp 1/2-inch long integral crimp ring “F” connector with specific recommendation by the connector manufacturer that it is compatible with the manufacturer and part number of the coaxial cable. The terminated cable will be attached to an “F” female to female splice (or barrel) in the faceplate. The splice or barrel will be of sufficient length that after installation in the faceplate with nut and washer there is still enough splice exposed to install and “F” connector such that the rotational part of the connector does not bottom out before the ferrule tightens up to the splice.

E. Video cable in the Telecommunications room will terminate with a hex crimp 1/2-inch long integral crimp ring “F” connector with specific recommendation by the connector manufacturer that it is compatible with the part number of the coaxial cable. Each terminated cable will be attached to a splice barrel on a 96-port, bottom hinged, “F” type, female-to-female coax patch panel. A #10 ground wire will be run from each wall mounted patch panel to the TGB in the room. Each cable will be identified with a tag that has the jack number printed on it in a neat and legible manner. i.e. Brady Label-heat shrunk to cable.

F. Horizontal multimode fiber optic cable will terminate on duplex SC connectors at both ends. The closet connector will be placed in a fiber distribution center mounted in a 19-inch rack equipped with a cable management system. At the wallplate the connector will be placed in a multimedia outlet, designed for fiber optic applications.

G. Backbone multimode fiber optic cable will terminate on ST connectors at both ends. The connector will be placed in a fiber distribution center mounted in a 19-inch rack equipped with a cable management system.

H. Singlemode fiber optic cable in the Telecommunications room will terminate on SC/APC connectors. The connector will be placed in a fiber distribution center mounted in a 19-inch rack equipped with a cable management system.

I. Horizontal, Intrabuilding Backbone, and Interbuilding Backbone fiber optic cables shall each be mounted in separate fiber distribution centers by category unless otherwise indicated on drawings.

2.8 IDENTIFICATION – TELECOMMUNICATIONS EQUIPMENT
A. Horizontal cables, entrance cable, house cable and fiber cable shall be labeled at each end by means of a tag affixed to the cable. The numbering system for horizontal cable shall follow the chart located on the drawings. The numbering system for all other cables shall be as shown on the drawings or as directed.

B. Faceplates will be marked with 26 point medium numbers, 3/8 inch tape, black numbers on clear tape. Each jack will be numbered with its corresponding relative position in the patch panel, 110 blocks, or assigned video number. Jack numbers will be recorded on the drawing according to outlet number.

C. Telecom closets shall be designated as Telecom Room A, Telecom Room B, etc. All jack numbers will be preceded by the letter designator for the closet that feeds it, i.e., A1 through An, and B1 through Bn, or A0101 through A0196, etc. Buildings with a single closet shall be designated as TELECOM ROOM A.

D. Patch Panels and Jack Numbers
   1. Under the Universal Wiring Model, patch panels shall be identified by the closet designator (A, B, etc.), and a two digit panel number; A01, A02, A03, etc., using 36 point medium width numbers. Factory jack numbers (1-96) shall be retained, therefore specific jack numbers are identified as to the closet, patch panel and jack number. Examples: A0101, B0196, etc. The jack number shall be identified on the faceplate.
   2. Under the Universal Wiring Model, the Voice Jack Panels shall be identified by the designator “X” and a two digit panel number; X01, X02, X03, etc., using 36 point medium width numbers. Factory jack numbers (1-96) shall be retained. The corresponding 110 block shall have the same designation, and the 110 wiring blocks shall be identified to directly correspond to the patch panel jack numbers.
   4. Coax patch panels shall be identified by the designator “V” and a two digit panel number; V01, V02, V03, etc, using 36 point medium width numbers. Each port will be marked with 10 point medium width numbers with 3/8 inch tape, white on black tape. Each port will be numbered starting with 1 through (n) in numerical order left to right, top to bottom on the jack side of the panel. This same number shall be identified on the faceplate, examples: V0101, V0196, etc.

E. 110 blocks will be marked with 10 point medium width numbers with 1/2 inch black clear tape. The numbering sequence will be 1 through (N) in numerical order starting with the top left to right, top to bottom. Per vertical column. Column will expand left to right.

2.9 ACCEPTANCE TESTING

A. Cable testing. All category 6 cable will be link-tested to include the jack at the faceplate, and the patch panel or terminated block using test parameters as outlined in the TIA/EIA TSB-67 standard. Tests will be completed with a test set that complies with TSB-67 Accuracy Level II. Results will be provided on a CD and submitted to Telecommunications and Network Services (TNS) for approval. If special software is required to access the test results, a copy of the software or download URL shall also be provided.

B. Coaxial cables are to be tested with a TDR to verify location, leakage and dB Attenuation loss. A printed copy of the results will be turned over to TNS for approval.

C. Inside fiber optic cables are to be tested in both directions with a power meter. A printed copy of the results will be turned over TNS for approval.
D. Outside Plant Fiber Optic Cable Testing

Provide the following documentation for each fiber:

1. OTDR trace from each end at a wavelength of 830 nm or 1300 nm in hard copy form or on a disk. A leader spool of sufficient length to exceed the dead zone of the OTDR is required.
2. Power meter measurements of optical loss at wavelength of 830 nm or 1300 nm for each fiber from each end. Recorded readings are to be supplied in hard copy form or on a disk.

E. Contractor shall provide a complete set of as-built drawings and completed Jack Matrix (see below), within 3 days of completion of final testing and installation.

F. Contractor will provide a Jack Matrix in an Excel spreadsheet format. TNS will provide the format to the contractor. The Jack Matrix will indicate, for each installed jack, the Building Number, Outlet Number, Room Number, Jack Type (V=Data, U=Voice, C=Universal, U=Coax, F=Fiber, Jack number, Telecom Room number. This will be turned over to TNS for approval.

2.10 TRANSFER OF SERVICE

1. Copper Cable

   a. The Contractor shall be responsible for extending the building feed from the existing location to the new Telecommunications room. The incoming copper cable shall be bridged ahead of the existing termination or protection and extended to the new protection within the new room. (see section 2.01 Entrance Cable) The bridge shall be left in place until all working service is transferred to the new Telecommunications room. The bridge splice shall be accomplished by use of Lucent 710 splicing modules or 3M 4000 series splicing modules. All cables shall be bonded across the splice opening using cable bonding clamps and 1/2 inch wide grounding braid with eyelet’s. The ground integrity of the distribution cable shield shall be maintained at all times. A air dam shall be installed on the incoming side of the splice and shall be equipped with a valve to be used for testing the air pressure on the incoming side of the dam. The splice shall be wrapped to provide mechanical protection until the service is transferred and the bridge can be cut out.

   b. The Contractor shall be responsible for transferring the working service into the new wiring. Test results will be provided to TNS before service is transferred.

   c. After all service has been transferred the Contractor shall remove the bridge, existing cable, termination devices and terminal housings. The splice shall be enclosed with a Lucent 2000 series fire retarding closure or approved equivalent designed for use in building applications.

2. Coax Cable:

   a. The Contractor shall place two RG-11 coax cables from the entrance facility to the new Telecommunications room. These cables shall terminate on grounding blocks with F-connectors in the Telecommunications room and have F-connectors installed at the entrance facility with enough cable to connect to the 1/2-inch building feed trunk cable. The grounding blocks shall be bonded to the TMGB in the Telecommunications room.

   b. The University shall be responsible for transferring the working service.
c. After the service is transferred the Contractor shall be responsible for removing the wiring that the service was removed from.

3. **Fiber Cable**

   The contractor shall place fiber optic cable between the current telecommunications room and the new telecommunications room. See drawing [C]

**PART 3 - Section 3 – Materials**

### 3.1 **ENTRANCE CABLE**

A. Cable, twisted pair, building entrance, shall be of the pair quantity as indicated on the drawings. Cable shall be UL listed type CMR or CMP if required, unless otherwise noted on the drawings. All cable shall be plenum rated unless otherwise noted.

B. Cable, twisted pair, outside plant, shall be of the pair quantity as indicated on the drawings. Provide gel filled or air pressurized as noted on the drawings.

C. Cable, coaxial, shall be of the quantity and type as shown on the drawings.

D. All entrance cable shall be run in IMC conduit as required by the NEC.

E. Outside plant splices shall be Lucent 710 splicing modules or 3M 4000 series splicing modules, unless otherwise noted on the drawings or required to match existing. All cables shall be bonded across the splice opening using cable bonding clamps and ½ inch wide grounding braid with eyelets. The ground integrity of the distribution cable shield shall be maintained at all times.

1. For air-pressurized applications, an air dam shall be installed on the incoming side of the splice and shall be equipped with a valve to be used for testing the air pressure on the incoming side of the dam.

2. The splice shall be housed in a closure designed for use in underground or aerial applications, as required for the location.

3. Closures for air-pressurized application shall be specifically designed for use in air pressure system.

4. Closures for gel filled cable applications shall be filled with a re-enterable encapsulant which can be removed from the splice closure for future splicing operations.

5. Splice/Closures shall be chosen based on the size, pair count and number of cables entering and exiting the splice closure. Provide straight, branch, butt or special closures as required for the application and space available within manholes.

F. Provide entrance cable pair protection for all buildings. Provide AT&T 188 110 type unless noted. Provide pair count adequate for entrance cable. All protector panels shall be fully populated with 4B1E-W protectors, unless a different type of protector is noted.

### 3.2 **DISTRIBUTION RACK, PATCH PANELS AND ACCESSORIES**
A. The distribution rack must be 84-inches high and 19-inches wide, double sided, made of aluminum and equipped with vertical and horizontal cable management system. Per EIA/TIA Standards.

B. Provide vertical wire management brackets equivalent to LEVITON cat. No. 49260-BKT. Provide at a minimum of 6 per vertical rack section, located at the top of each horizontal wire management section.

C. Horizontal cable management shall be 3.5" Hubbell MCCMP2U, B-Line SB-719-19-2XL, T & B Wire guide, 19" x 3" model 028-9971-X2-20, or equivalent. Locate one (1) between each Patch Panel.

D. Patch Panel shall be 7" high, 96 port (ONLY), Category 6, Hubbell P696U or equivalent by Leviton or Amp. Provide one port for each horizontal cable run intended to terminate at the patch panel. Provide approximately 10% spare ports, with a minimum of 12 spare ports, and a maximum of 96 spare ports per building.

E. Voice Jack Panel shall be 7" high, 96 port (ONLY), Category 6, Hubbell P696U or equivalent by Leviton or Amp. Provide one port for each trunk cable pair unless otherwise indicated on drawings. See drawings for details.

F. Provide a center rail, single sided aluminum cable tray continuously bolted with 1/2" x 8" carriage bolt across the top of the racks. Tray shall be bolted from top of the rack up through the tray, with the excess bolt length extending up above the tray. Provide a lock washer at the rack side, and a fender washer on the top of the tray. The Tray shall have 6" load depth, 12" width and 6" rung spacing. Provide B-Line “Half- Rack” model C6A1H0612 or equivalent in lengths as required. Provide additional tray between the racks and the walls as shown on the drawings. Provide wall mount brackets, bend and tee accessories as required for a complete installation.

3.3 CATEGORY 6 PREMISE CABLE


B. Horizontal UTP cable, CMR or CMP rated sheathing, four pairs of 24 AWG solid conductor verified Category 6, enhanced performance cable per jack. Cable shall use only non-bonded pairs and shall be round in configuration.

C. All terminal blocks and mounting brackets are to be from one manufacturer, 110 type, Category 6 rated, and meet EIA/TIA Standards.

3.4 JACKS

A. Universal- Category 6, jack, T568B, gray, Hubbell Catalog number HXJ6GY or equivalent by Leviton.

3.5 CATEGORY 6 PATCH CABLES

A. Provide all necessary Category 6 patch cables necessary to perform the service transfer. [C]
B. Provide (1) patch cable for each telecommunications cable. [C]

C. Patch cables shall be 4-pair and a suitable length for the installation. Slack in excess of 20% of the cable length is not acceptable.

D. Patch cables shall be suitable for use in high-density patch panels and electronics.

E. Patch cables shall be factory assembled. Field terminated patch cables are not acceptable.

F. Patch cables for voice applications shall be violet and data applications shall be orange.

3.6 FIBER OPTIC CABLE

A. Single Mode Loose Tube Fiber
   1. Shall have the following specifications:
      a. a core diameter of 8.3 microns
      b. a cladding diameter of 125 microns
      c. a maximum attenuation of:
         1) 0.44 dB/Km @ 1310 nm
         2) 0.35 dB/Km @ 1550 nm
      d. a zero dispersion wavelength of 1310+/-10 nm
   2. Shall have a sheath rated and marked OFNR for riser applications per NEC.
   3. Shall have distances marked on the outside in feet in such a way that normal installation does not rub them off or make them unreadable.
   4. Shall have a nonmetallic strength member.
   5. Shall be non-armored.
   6. Shall be suitable for underground and aerial installation.
   7. Have a minimum of 6 and a maximum of 12 fibers per buffer tube
   8. Shall use standard color codes on sub buffers per EIA/TIA. SPECIFICATION 598:
      a. Blue    g. Red
      b. Orange  h. Black
      c. Green   i. Yellow
      d. Brown   j. Violet
      e. Slate   k. Rose
      f. White   l. Aqua
   9. Shall have loss and zero dispersion wavelength data sheets supplied for all fibers.
   10. Shall have a pull cord to facilitate the removal of the sheath. KEVLAR cords are NOT acceptable.
   11. Shall have the footage specified -0%+1%.
   12. Termination and Splicing
      a. Fiber will be terminated in a patch panel at each end to facilitate cross-connections.
      b. Fiber will be directly terminated with SC compatible connectors.
      c. Fiber may be spliced using fusion splices.
      d. All patch panels will be labeled as to sheath number (ie. UNF##), fiber number, and location of the opposite end. This information will be provided on the splicing drawings supplied by Penn State.

B. Multimode Loose Tube Fiber
1. Shall be 62.5/125 um, multimode, graded index, dual window.
2. Shall have a numerical aperture of 0.275.
3. Shall be rated FDDI Plus
   a. i.e. have a maximum attenuation of:
      1) 3.75 dB/Km @ 850 nm
      2) 1.5 dB/Km @ 1300 nm
4. have a minimum bandwidth of:
   a. 160 Mhz-Km @ 850 nm
   b. 500 Mhz-Km @ 1300 nm
5. Shall have a rating of OFNR
6. Shall have distances marked on the outside in feet
7. Shall have a nonmetallic strength member
8. Shall be non-armored
9. Shall be suitable for underground installation in conduits
10. Have a minimum of 6 and a maximum of 12 fibers per buffer tube
11. Use standard color codes per EIA/TIA specification 598.
    a. Blue         g. Red
    b. Orange       h. Black
    c. Green        i. Yellow
    d. Brown        j. Violet
    e. Slate        k. Rose
    f. White        l. Aqua
12. Shall have loss and bandwidth data sheets supplied for all fibers.
13. Shall have a pull cord to facilitate the removal of the sheath. KEVLAR cords are NOT acceptable.
14. Shall have the footage specified -0%+1%.
15. Shall be supplied on nominal 1 km reels
16. Terminating and slicing
    a. Fiber will be terminated in a patch panel at each end to facilitate cross-connections.
    b. Fiber will be directly terminated with ST compatible connectors.
    c. The fiber will be protected with a subunit buffer from the connector to the buffer tube in the outside cable so that no bare or acrylic clad fiber is exposed.
    d. Fiber will be fusion spliced were splicing is required.
17. All patch panels will be labeled as to sheath number (ie. UNF##), fiber number, and location of the opposite end. This information will be provided on the splicing drawings supplied by Penn State.
18. Hybrid fiber cable shall be one piece with fiber counts as indicated, with the fiber in accordance with the above specifications.
19. Tight-buffered fiber optic cable shall have 900 micron buffer diameter, with the fiber in accordance with the above specifications.

3.7 FIBER OPTIC PATCH PANEL

Provide Lucent Technologies Fiber Optic Shelf Termination, LST1U Series. Panel shall be rack mounted, front and clear accessible. Provide with all associated mounting and accessory hardware. Provide in 12, 24 or 72 fiber capacity as required.
3.8 VIDEO CABLE AND ACCESSORIES

A. Cable, coaxial shall be RG-6 with a CATVR or CATVP rated sheath, 75-ohm (+ or - 2 ohms) with a 60% aluminum or copper braid and inner-shield aluminum tape bonded to the dielectric, one home run per outlet.

   Foam dielectric
   Bonded-foil type
   18 AWG Copper-covered steel center conductor
   Outer shield of polyvinylchloride or polyethylene
   Maximum attenuation from 5 to 750 MHz shall be 5.65 dB/100ft
   Com Scope F660BVR (riser) or 2275V (plenum) or equivalent

B. Coax cable patch panel shall be wall mounted 96 port bottom hinged panel. Provide 96 “F” type female to female splice (Barrel) connectors in each patch panel.

C. Video splitters will be capable of 1 Ghz bandpass with a maximum insertion loss of 14 dB and have a return loss of greater than 15dB and have minimum port-to-port isolation of 20 dB. They will be capable of being mounted on a plywood backboard and have provision for the attachment of a #10 ground wire that will be run to the TGB in the closet.

3.9 WALL PLATES

Outlet wall plates shall be satin-finished 20 gauge, stainless steel. Plates shall be single gang with 4 openings or double gang with 6 openings as appropriate for the outlet location. Screws shall be stainless steel with counter sunk heads and finished to match the plates. Plates shall accommodate various manufacturers high-density jacks so that the surface of the jack is flush with the surface of the faceplate. They shall also accommodate a snap in adapter to hold a coax barrel and a blank snap in for unused holes. The surface of these snap in adapters shall also be flush with the surface of the faceplate. Provide Semtron model 1FM-(4)OE or 2FM-(6)OEA, or equivalent.

Wall phone plates shall be satin-finished 20 gauge, stainless steel, single gang. Screws shall be stainless steel with counter sunk heads and finished to match the plates. Plates shall accommodate various manufacturers high-density jacks. Provide Semtron model WP505-PHONE-DP, or equivalent.

3.10 BONDING AND GROUNDING

The metallic shield of all the entrance cables, backbone cables, all wire trays, racks, panels and protectors shall be bonded to the TMGB with a minimum #6 AWG insulated wire.

All eight way splitters, chassis grounding points for key system and power units shall be bonded to the TMGB with #10 AWG wire.

All electronic devices and equipment shall be bonded to the TMGB per the manufacturers specifications.
All requirements of ANSI/TIA/EIA-607 shall be met.

3.11 EQUIPMENT CABINETS


2. Equipment cabinets shall meet the following requirements:
   a. NEMA-4 classification
   b. Dimensions – 30"W x 32"D x 87"H
   c. Inside of cabinet shall contain standard EIA 19" rack-mount equipment mounting rails full height, centered in the width of the unit.
   d. Have two flush, removable side walls.
   e. Have flush, swing open front and rear doors, with door switch and lockable handle on the front door. Lockable handle may be either suitable for hasp lock, or may be integral with the handle. All doors and removable panels shall be fully gasketed.
   f. Finish shall be black or gray, textured powder paint.
   g. Construction – Fully welded and rigid fabricated from 11 GA, 12 GA and 13 GA steel minimum. Doors and removable sides shall be constructed of 16 GA steel minimum.
   h. Allow Bottom Cable Entry

3. Equipment cabinets shall be equipped with air conditioning meeting the following requirements:
   a. 3925 BTU (+/- 10%) Top Mount Air conditioner, 9.2A, 115V, single phase.
   b. Provide with filters, air deflectors and condensate drain line.
   c. Provide digital thermometer/thermostat.
   d. All electrical and control circuits for the Air Conditioner shall be completely pre-wired, to a single junction box, suitable for a single connection by the installation contractor.

4. Equipment cabinets shall come equipped with the following accessories:
   a. Enclosure Light, 15W fluorescent, 18", with on/off switch
   b. Ground Bus and Grounding Kit
   c. Grounded Power Strip with three stage surge protection, illuminated power switch (illuminated when "on"), circuit breaker protection with reset switch. Power strip shall be mounted in one of the inside support rails, accessible from the front of the cabinet. Power strip shall have a minimum of six (6) NEMA 5-15R receptacles
   d. Four (4) adjustable leveling feet

5. The light, power strip and AC unit shall be pre-wired to a single junction box. The power strip and light shall be on one circuit, the AC unit on a separate, 2nd circuit. [C]
3.12 CONDUIT AND FITTINGS

Conduits


Fittings:

EMT: Couplings: Malleable iron or galvanized steel, compression type. Connectors and bushings: Same as couplings, except factory pre-insulated. Manufacturer: Appleton, Crouse Hinds, Killark, Thomas & Betts, or approved equal.

RS and IMC: Couplings and connectors of same material as conduit; threaded.

Flexible Conduits: Squeeze clamp type or screw-in type. Factory pre-insulated.

Sleeves:

The contractor shall provide and install sleeves where required to protect equipment or facilities in the installation. Each sleeve shall extend through its respective floor, wall or partition and shall be cut flush with each surface unless otherwise required.

Sleeves in bearing and masonry walls, floors and partitions shall be of standard weight steel pipe finished with smooth edges. For other than masonry partitions through suspended ceilings, and for concealed vertical piping, sleeves shall be No. 22 U.S.G. galvanized iron.

All sleeves shall be properly installed and securely cemented in place.

Floor sleeves shall extend 1 inch above the finished floor. Space between floor sleeves and passing conduit shall be caulked with graphite packing and waterproof caulking compound as approved.

Sleeves through exterior walls below grade shall have the space between conduit and sleeve caulked watertight.

Installation:

The contractor shall provide and install inserts of an approved metallic type for all hangers. Where two or more parallel conduits are installed, continuous inserts may be used. Where required to distribute the load on the inserts, a piece of reinforcing steel of sufficient length shall be passed through the insert.

Fasten conduits to pull boxes, cabinets, terminal boxes, etc., with two locknuts or acceptable fittings and provide insulation bushing. Bushings shall not function as fastening device in lieu of interior locknut. Conduits shall be concealed in finished spaces.
Bends: Pre-manufactured type for larger than (one) 1 inch. Bends shall not reduce original free cross section area.

Ground entire conduit system.

Expansion Joints: provide where conduits cross building expansion joints, where exposed conduit runs in straight lengths exceeding 150 feet.

f. All empty conduits shall have conduit measuring tape installed within them. The measuring tape shall be suitable for use as a pulling line. The conduit measuring tape shall be 130 lb. tensile strength Greenlee 435, or equal. On conduit size two (2) inches or larger, the conduit measuring tape shall be of minimum of 600 lb. Test. All pull lines shall be suitably identified as to origin, intermediate pull points, and termination. Specific locations of origin, intermediate pull points and termination point shall be indicated.

g. Exposed Conduits shall be installed parallel or at right angles to walls, ceilings and structural members. Exposed conduits in painted areas shall be painted to match the existing finish, and shall only be installed with prior approval.

h. Rigid Steel Conduit (RSC) and Intermediate Metal Conduit (IMC) shall be used regardless of location for all conduits larger than 4 inches, unless otherwise specified.

3.13 NAMEPLATES:

Black and white laminated lamicoid.

Lettering engraved through black surface exposing white lamination beneath.

Mount with minimum two machine screws or pop rivets. Glued-on nameplates not acceptable.

Size and letters 3/16 inch minimum.

3.14 OUTLET BOXES:

Interior - Recessed mounted: Galvanized or sherardized, one piece pressed steel, knock-out type. Ensure box depth is compatible with wall assembly. In plastered walls use a minimum double-gang outlet box. Check field conditions for exact location to center with architectural features, panels, tiles, etc. Approximate locations are shown on drawings. Outlet boxes shall be recessed in finished spaces where possible.

Interior - Surface mounted: Select to match surface raceway. Surface mounted installations in finished spaces are acceptable only if walls cannot be fished. Check field conditions for exact location to center with architectural features, panels, tiles, etc. Approximate locations are shown on drawings. Outlet boxes shall be recessed in finished spaces where possible.

Exterior or mechanical plenum spaces: Cast iron with threaded hub. Gasketed cover. Type FS or FD as required.

3.15 PULL BOXES:

Provide as required. Code gauge galvanized steel. Removable cover fastened with minimum four machine screws. Slide-on or snap-on cover not acceptable.
3.16 **FIRE STOPPING**

Firestop systems shall be installed in all openings and around all penetrating elements or devices as required by these Contract Documents, and as required by applicable design, building and construction codes, subject to the interpretation of the authority having jurisdiction.

Firestop materials shall have the approval of the authority having jurisdiction.

Nelson FSP, Flame seal: A ready to use, permanently pliable intumescent putty.

Nelson CLK: A one part, silence based, non-sagging, adhesive sealant.

Nelson CMP: A non-slump, cementitious sealant.

Nelson PLW: A ready to use, intumescent fibrous material enclosed a strong polyethylene envelope.

Nelson RSW: Intumescent coated mineral wool strips which may be used in conjunction with Nelson CLK.

Verify that all penetrating elements and supporting devices have been installed and all temporary lines have been removed.

Surfaces in contact with penetration seal materials shall be clean and free of dust, dirt, grease, oil, loose materials, rust or other substances.

Install penetration seal materials in accordance with design requirements and manufacturer’s instructions.

Follow manufacturer's recommendations to obtain a smooth, professional finish.

If forms or damming materials are installed, they shall be removed after the designated cure time unless the support materials used are of a fire resistant or non-combustible nature.

END OF SECTION 27 15 00
PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Introduction

The Contractor shall provide, install, and program a functionally complete integrated access control, electronic locking, and door monitoring system per Manufacturer’s guidelines and codes, as described in the following specifications.

B. Work included under this section

1. Installation of access control system including:
   a. Sensormatic access control panel.
      • Sensormatic iStar panel in T217
   b. Eight (8) Card reader doors/door sets.
   c. Two (2) Electric locking, controlled doors/door sets
   d. Two (2) Monitored doors/door sets.

2. Equipment Schedule

See Appendix 1 for Equipment Schedule.

See Appendix 2 for door library for Type

3. System Wiring

   a. All system wiring shall be plenum rated.
   b. Wire gauge and shielding shall follow the manufacturer’s installation guidelines.
   c. All wiring shall be installed in accordance with the National Electric Code (NEC) and the National Fire Protection Agency (NFPA).
   d. All wiring shall be concealed where possible. All exposed wiring shall be installed in a protective housing such as conduit or Wiremold.
   e. Cables penetrating floors and firewalls must be routed through a metallic sleeve and properly fire stopped to meet national and local fire codes. All walls and floors shall maintain their existing fire rating.

4. System Programming

   a. The Contractor shall complete the programming of all inputs, outputs, readers, events, doors, and iStar panels.
   b. The Contractor shall utilize the University’s standard naming conventions.

5. Related Work Specified under Other Sections of these Specifications (Related sections)

   a. This work shall be done in strict accordance with these Contract Documents prepared for The Pennsylvania State University, herein after referred to as “Owner”.
   b. The Contractor shall perform all work described in this document along with any work not expressly mentioned in the specifications, but obviously necessary, for the proper execution of the same. It is not the intent to delineate or describe every detail and feature of work. No additions to the contract sum will be approved for any materials, equipment, and/or labor to perform work hereunder unless it can be clearly shown to be beyond the scope and intent of the drawings and specifications and absolutely essential to the proper prosecution of the work.
c. Work under this contract consists of the complete installation and includes, but is not necessarily limited to, the furnishing of all labor, superintendence, material, tools, and equipment necessary to complete all the work as specified hereinafter.

1.2 GENERAL CONDITIONS

A. Submittals at Bid Time

For bid evaluation, bid submittals shall include two (2) sets of the items described below:

1. Specification sheets (cut sheets) of all proposed equipment.

2. Equipment list identifying:
   a. Model number of each unit
   b. Quantities of each type of device
   c. Unit costs

3. Specification Compliance: Shall constitute a letter submitted with the bid, responding to specification sub-sections individually, indicating exceptions, substitutions, and alternatives. The Contractor shall submit requests for substitutions (as well as all relevant technical data pertaining to substituted equipment) to the specifier ten (10) days prior to the close of bid for evaluation and approval.

B. Documentation to be Submitted by Contractor after Award of Contract

1. Drawings: Shop drawings to provide details of proposed system and the work to be provided. These include point-to-point drawings of systems and wiring diagrams of individual devices.

2. Permits: The Contractor shall be responsible for identifying requirements for permits from all building, police, and fire authorities for the installation of the system(s) specified herein and shall assist Owner in obtaining the relevant permits.

C. Documentation to be Submitted by Contractor upon Completion of System Installation

1. “As-builts”: Upon completion of installation, the Contractor shall prepare “as-built” drawings of the system. These “as-builts” shall be AutoCAD (Revision 14 or greater) drawings of each floor plan indicating exact device locations, panel terminations, cable routes, and wire numbers as tagged and color-coded on the cable tag.

   In addition, final point-to-point wiring diagrams of each type of device (in AutoCAD) shall be included in the “as-builts.”

   “As-builts” shall be submitted to the Owner for approval prior to the system acceptance walk through.

2. Operation and Maintenance Manuals: One (1) set of operating manuals shall be provided explaining the operation and maintenance of the system.

3. Paperwork to be placed inside of iStar panel:
   a. iStar installation manual
   b. Reader and reader interface manual
   c. Door release hardware manuals
   d. Request to exit motion detector manuals
   e. Power supply manuals
f. All wiring notes

D. On-site Security Personnel Training

Upon completion of the installation, the Contractor shall furnish training in the complete operation of the system.

E. System Approvals

1. The system shall be the standard product of one manufacturer, and the manufacturer shall have been in business manufacturing similar products for at least five (5) years.
2. After-Sales Support: The Contractor shall be a factory-authorized and trained dealer of the system and shall be certified to maintain/repair the system after system acceptance.

F. Quality Assurance

1. All equipment, systems, and materials furnished and installed under this section shall be installed in accordance with the applicable standards of:
   a. National codes: NEC and NFPA
   b. Approvals and Listings: UL
   c. Pennsylvania Department of Labor and Industry
   d. EIA/TIA Telecommunications wiring standards
   e. Local Authorities Having Jurisdiction

G. Guarantee of Work

All components, parts, and assemblies supplied by the Manufacturers and installed by the Contractor shall be warranted against defects in material and workmanship for a period of at least twelve (12) months (parts and labor), commencing upon date of acceptance by Owner. A qualified factory-trained service representative shall provide warranty service.

H. Service/Maintenance

1. The Contractor shall be responsible for maintenance and repair of the system during the warranty period, free of charge (parts and labor), including the repair of workmanship defects.
2. The installer shall correct any system defect within six (6) hours of receipt of call from Owner.
3. The Contractor shall offer extended service/maintenance agreements up to four (4) years after the warranty expires. The agreement shall be renewable monthly, quarterly, or yearly.

I. Building Security

Building security shall remain functional during installation. Doors and door locking shall remain operational. University Police must be notified if it is not possible to lock the doors at the end of each workday. Failure to comply will result in removal from the approved vendor list.

1.3 HANDICAPPED DOOR OPENER INTERFACE

A. Handicapped Door Operation

1. Exterior Handicapped Button
   a. Button is disabled when building is locked.
   b. Button is enabled with a valid card read when building is locked.
   c. Button opens door without card read when building is unlocked.
2. Interior Handicapped Button
   a. Button unlocks door then opens door when building is locked.
   b. Button triggers request to exit input on RM-4 module.
c. Button opens door when the building is unlocked.

1.4 READER LED OPERATION

A. LED Sequencing

1. LED table for Mercury card readers and Schlage VIP open architecture locks:

<table>
<thead>
<tr>
<th>Red LED</th>
<th>Green LED</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>Off</td>
<td>Online – Door Locked</td>
</tr>
<tr>
<td>Off</td>
<td>Off</td>
<td>Offline or reader tamper</td>
</tr>
<tr>
<td>Off</td>
<td>On</td>
<td>Access granted or door unlocked</td>
</tr>
<tr>
<td>Off</td>
<td>Fast flash</td>
<td>Access Granted</td>
</tr>
<tr>
<td>Off</td>
<td>Slow flash</td>
<td>Door unlocked</td>
</tr>
<tr>
<td>Fast flash</td>
<td>Fast flash</td>
<td>Alarm: door forced/held open</td>
</tr>
</tbody>
</table>

2. Sensormatic card readers use standard set-up as specified in apC/iStar technical manual.

1.5 MAGNETIC LOCKS

A. Approvals

Due to the life safety concerns the use of magnetic locks is prohibited unless approvals from A.C.E.S Group and A.H.J (Authority Having Jurisdiction) are granted. All approved magnetic locks shall be installed in accordance with all life safety regulations and NFPA codes.

PART 2 - Products

2.1 ACCESS CONTROL SYSTEM

A. Access Control System Description

The Pennsylvania State University has initiated a multi-phase access control project for the University Park campus. The existing system utilizes Software House CCure800/8000 software running on a CCure server. The hardware consists of Sensormatic iStar Controller and associated hardware, which provides for the physical connection to readers, locking hardware, door status switches, and request to exit devices.

Sensormatic has been approved as a Proprietary Item and substitutions will not be permitted without permission of Owner.

B. Sensormatic System Feature/Capability

The following indicates system capabilities and capacities:

1. LAN/WAN Communications: CCure host server to local iStar panel.
2. The iStar panels shall have a minimum of 64MB RAM to exceed the University requirement of 10,000 card records and 3,000 event storage capabilities to retain event information in the case of network failure.
3. Programming Software: The Programming Software shall include the following features:
   a. LAN/WAN connection with CCure Host
   b. Fully configurable user authority level control
   c. CCure parameter editing and storage
   d. CCure and iStar software upgrade ability
C. Sensormatic System Interface Requirements
1. All Installations: The Sensormatic access control system shall be installed in accordance with the National Electric Code and the local Authority Having Jurisdiction (AHJ).
2. The Sensormatic access control hardware shall be installed in accordance with UL requirements.

2.2 SENSORMATIC SYSTEM MATERIALS

A. Sensormatic System Hardware Description
1. Sensormatic System: The access control system shall be provided, at a minimum, with the following components. Additional accessories shall be provided based on the quantities and features required for the application.
   a. Sensormatic panel iStar.
      • System Accessories:
        1) 64 MB RAM or greater
        2) iStar power supply with 7 amp hour battery backup for panel and door strikes
           a) Mercury part # WS-10 hood required for outdoor readers.
           b) Mercury MR-10 Card Readers
           c) Sensormatic RM-4 personality module
           d) Von Duprin PS873 power supplies for electric latch retraction activation
           e) Von Duprin exit hardware mounted request-to-exit switches
           f) Von Duprin electric latch retraction solenoids
           g) Von Duprin 6000 Series electric door strikes
           h) Sentrol #1078C door monitor switches
           i) Detection Systems DS150i request-to-exit motion detectors
           j) System Sensor PA440 door ajar sounders
           k) Tripp-Lite Model# IBAR4 or equivalent surge suppressor.
           l) Handicapped door opener interfaces.
           m) Altronix AL400ULACMCB or equivalent power supply
           n) Von Duprin EPT-10 power transfer device
2. Sensormatic iStar (Advanced Processing Controller)

B. iStar Advanced Processing Controller Description
   The iStar specified herein shall be used to control the locking/unlocking of doors

C. iStar Feature/Capability Summary
   The following indicates the iStar / iStar capabilities, capacities, and formats:
1. Advanced Processing Controller (iStar): The iStar shall include the following features:
   a. Must have re-programmable FLASH memory for software upgrades and future product enhancements.
   b. Must contain a 3,000 Event history buffer (minimum)
   c. Must support 50,000 or greater card holders
   d. Possess the capability of 255 time commands for automatic input, output, and reader mode control
   e. Must have the ability of elevator control
   f. Must possess real-time full-year clock and calendar
D. iStar System Interface Requirements
1. Grounding: The Contractor shall properly earth ground the iStar panel to prevent electrostatic charges and other transient electrical surges from damaging the iStar panel.
2. Primary power: The Contractor shall connect the iStar panel to a dedicated 120 VAC power source through the external iStar power supply.
3. Power supervision: The external power supply shall provide contacts that activate when there is an AC power failure and the system will report a “Power Failure” message to the CCure server.
4. Communications: The Contractor shall connect the iStar to the Universities SecLAN for communications and programming with the CCure host server.
5. Housing: The Contractor shall install the iStar in a 16 AWG metal wall mounted lockable cabinet with tamper switches on the front and rear. (Standard Sensormatic Cabinet).

2.3 MERCURY SECURITY CORPORATION – MODEL MR-10 CARD READER

A. MR-10 Card Reader Description
The card reader specified herein shall be used to read Pennsylvania State University id+ cards for the purpose of providing access control to secured areas of the University Park campus.

B. MR-10 Feature/Capability Summary
The following indicates reader capabilities and formats:
1. The MR-10 shall be used to read standard ABA (American Banking Association) Track II cards.
2. Read speed shall be from 3 to 50 inches per second.
3. Communication formats shall be either clock/data or Wiegand.
4. Reader head shall provide a life expectancy greater than 1,000,000 reads.
5. Outdoor applications shall have the optional weather hood installed.
6. Reader shall be equipped with two visual indicators (LEDs) and an audible tone.
7. Housing shall be die cast metal and the mounting hardware shall be stainless steel.
8. Reader shall be capable of normal operation indoor, outdoors, and between the temperatures of –40°C and +75°C.

C. MR-10 Interfacing Requirements
1. Sensormatic RM-4 Personality Module: The Contractor shall install an RM-4 to interface the MR-10 reader to the iStar panel.
2. Grounding: The Contractor shall properly earth ground the RM-10 reader to prevent electrostatic charges and other transient electrical surges from damaging the reader.
3. Mounting: The Contractor shall mount the reader vertically, except where it is not possible. Then, the reader should be mounted with read slot along the bottom of the unit.

2.4 SENSORMATIC RM-4 PERSONALITY MODULE

A. RM-4 Personality Module Description
The RM-4 module specified herein shall connect and work as an interface between the MR-10 reader and the iStar access control panel. The RM-4 shall also provide inputs and outputs for the connection of a door status switch, request to exit switch, and door strike relay.

B. RM-4 Feature/Capability Summary

The following outlines RM-4 capabilities and formats:
1. The RM-4 shall be used to interface communications between the MR-10 card reader and the iStar access control panel.
2. The RM-4 shall be used to connect and supervise the door status switch and the request to exit switch/motion.
3. Provide an output/trigger for door strike relay.
4. Convert the clock/data communication format from the reader to RS485.
5. Create an address for the reader to the iStar.

C. RM-4 System Requirements

1. Grounding: The Contractor shall properly earth ground the RM-4 to prevent electrostatic charges and other transient electrical surges from damaging the RM-4.
2. Housing: The Contractor shall install the RM-4 in a NEMA Type 1 hinged, lockable enclosure along with the door strike relay (Altronix RSBN-TTL or Equivalent).

2.5 SENTROL 1078C DOOR MONITOR SWITCH

A. Sentrol 1078C Description

The 1078C Door Monitor Switch specified herein shall provide a means of monitoring the status of the controlled door. The switch will monitor the door for forced entry and indicate if the door is left ajar after a valid card read.

B. 1078C Feature/Capability Summary

1. Contact shall be hermetically sealed magnetic reed switch.
2. Reed switch shall be potted in the contact housing with a polyurethane-based compound.
3. Housings shall be molded of flame retardant ABS plastic.

C. 1078C System Requirements

1. RM-4 Connection: The Contractor shall connect the 1078C to the appropriate input on the RM-4.
2. Supervision Resistor: The Contractor shall connect the supervision resistor provided with the RM-4 at the 1078C for the supervision of the wiring between the resistor and the RM-4.
3. Securing the 1078C: The Contractor shall secure the 1078C in place by placing a light coating of silicon RTV caulk.

2.6 SENSORMATIC DS-150I REQUEST TO EXIT MOTION DETECTOR

A. DS-150i Request to Exit Motion Detector Description

The DS-150i request to exit motion detector specified herein shall provide a means to shunt the Door Monitor Switch and/or the unlocking of the controlled door upon exiting.

B. DS-150i Feature/Capability Summary

1. Coverage: The DS-150i shall provide coverage for single or double door use.
2. DS-150i shall be mounted above the door on the wall or ceiling.
3. Two sets of relays that shall be Form "C" contacts.
4. Selectable fail safe/secure modes
C. DS-150i System Interface Requirements
   1. RM-4 Connection: The Contractor shall connect the DS-150i to the RM-4 module.

2.7 ALTRONIX MAXIM3D POWER SUPPLY (OR EQUIVALENT)

A. Altronix Power Supply Description
   The MAXIM3D distributes and routes power to access control systems and accessories. It will
   convert an 115VAC 50/60Hz input into eight (8) independently controlled PTC protected class 2
   power limited 12VDC or 24VDC outputs. Outputs are activated by an open collector sink or
   normally open (NO) dry trigger input from an Access Control System, Card Reader, Keypad,
   Push Button, PIR, etc.

   The unit will route power to a variety of access control hardware devices including: Mag Locks,
   Electric Strikes, Magnetic Door Holders, etc. Outputs will operate in both fail-safe and/or fail-
   secure modes.

   The FACP Interface enables Emergency Egress, Alarm Monitoring, or may be used to trigger
   other auxiliary devices. The fire alarm disconnect function can be configured for the following
   modes: a) eight (8) outputs affected or b) four (4) outputs affected and four (4) outputs unaf-
   fected (50/50 mode).

B. Altronix Power Supply Features/Capability Summary
   1. 4 amp continuous supply cu rrent at 12 VDC or 24 VDC.
   2. Eight (8) Access Control System trigger inputs.
   3. Fire Alarm disconnect
   4. Automatic switchover to stand-by battery when AC fails.
   5. Thermal and short-circuit protection with auto reset.
   6. Battery failure and battery presence supervision.
   7. AC failure supervision.

C. Altronix Power Supply Interface Requirements
   1. Primary Power: The Contractor shall co nnect the power supply to a non-switched,
      dedicated 120 VAC power source.
   2. Power Supervision: The C ontractor shall connect the pow er supply’s supervisory outputs
      to the iStar.
   3. Battery Back-up: The Contractor shall provide for a minimum 12 hours of back-up power
      in the event of primary power failure.

2.8 VON DUPRIN 98/99 SERIES - ELECTRIC LATCH RETRACTION AND REQUEST TO EXIT OPTIONS

A. Von Duprin Electric Latch Retraction and Request to Exit Description
   1. Electric Latch Retraction (EL)- Option
      The EL feature allows for the remote unlocking of exit devices. A control station operator
      can flip a switch or an access control system can activate an output to retract the latch
      bolt and immediately change an exit door to push-pull operation. A powerful, continuous-
      duty solenoid retracts the latch bolt for unlocking either momentary or for extended
      periods of time. The EL feature is an alternative to manual dogging. EL devices are also
      useful with automatic door operators and may be applied to fire-rated devices when
      under the control of an automatic fire alarm system.

   2. Request to Exit (RX)-- Option: The RX (Request-to-Exit) feature is used to signal the use
      of an opening. These devices are equipped with one internal SPDT switch which
      monitors the touch bar. The device can be connected to a security console or may be
used as a single door alarm when used with a horn and power supply. A continuous current electric transfer must be used for transferring power from the frame to the door.

B. Von Duprin Features/Capability Summary
   1. Electric Latch Retraction
      a. Fail secure to keep door locked in the event of power failure
      b. Interfaces with automatic door opener for handicapped entrances.
      c. Can be retrofit into existing Von Duprin door hardware
   2. Request to Exit
      a. One internal SPDT switch
      b. Can be retrofit into existing Von Duprin door hardware

C. Von Duprin Interface Requirements
   1. Electric Latch Retraction
      a. Power: EL requires a separate power supply Von Duprin PS 873 with 872-1 option board.
      b. Power supply requires 120VAC
      c. The Contractor shall provide a continuous current electric transfer for transferring power from the frame to the door.
      d. iStar Connection: The Contractor shall connect the electric latch retraction to the iStar panel through a set of SPDT contacts.
   2. Request to Exit
      a. RM-4 Connection: The Contractor shall connect the RX switch to the RM-4 module.
      b. The Contractor shall provide a continuous current electric transfer for transferring power from the frame to the door.

2.9 VON DUPRIN 6000 SERIES ELECTRIC DOOR STRIKES

Electric door strikes shall be Von Duprin 6000 Series of the appropriate model for the associated door's lock. Any other substitution shall be submitted to PSU for approval. Note: Security vendor shall be responsible for specifying and installing of the appropriate model of electric strike.

A. Von Duprin 6000 Series Door Strike Description

Von Duprin electric door strikes provide remote release of a locked door. They allow the door to be opened without retracting the latchbolt. When the door closes the beveled latchbolt rides over the lip and falls into the electric strike pocket. With the Dual switch monitoring option, the strike has two SPDT contacts; one switch monitors the tripper, which is depressed when the latchbolt is inserted into the strike pocket. The second switch monitors the condition of the strike lip, open or closed and locked.

2.10 VON DUPRIN 6000 SERIES FEATURES/CAPABILITY SUMMARY

A. Fail secure to keep door locked in the event of power failure
B. Rated for continuous duty for daytime unlocking of doors
C. Tested to over 500,000 cycles
D. Holding strength greater than 1500 lbs.
E. UL Listed for Burglary-Resistant and Electric Strike for fire doors and frames.
F. Dual Switch Monitoring for latchbolt status and strike condition. Option: DS-LC (Latchbolt Status Switch)

1. Von Duprin 6000 Series Interface Requirements
   a. Power: The Contactor shall connect the electric strike to the Altronix power supply.
   b. Latchbolt Status Switch Connection: The Contractor shall connect the latch bolt status switch to the appropriate input on the iStar panel.
   c. Supervision Resistor: The Contractor shall connect the supervision resistor provided with the iStar panel at the latch bolt status switch for the supervision of the wiring between the resistor and the panel.

2.11 SYSTEM SENSOR PA400 MINI-ALERT SOUNDER

A. System Sensor PA400 Mini-Alert Sounder Description
   The PA400 Mini-Alert Sounder is a low current sounder (12mA @ 12VDC) that is affixed to a standard single gang electrical box. It will be used for annunciation of doors that have been propped open. It will typically be installed adjacent to the monitored door.

B. System Sensor PA400 Mini-Alert Sounder Features/Capability Summary
   1. The PA400 is capable of producing greater than 90db of audio.
   2. Mounts to a standard 2-1/2” deep single-gang box.

C. System Sensor PA400 Mini-Alert Interface Requirements
   1. Connection: The Contractor shall connect the PA400 to the appropriate outputs on the RM-4 module or apC8/X panel.
   2. Mounting: The Contractor shall mount the PA400 above the protected door unless otherwise specified.
   3. Activation: The PA400 shall be programmed to activate when the door is held or propped open.

PART 3 - Execution

3.1 INSTALLATION
   Install all equipment and materials in accordance with the “current” recommendations of the manufacturer. The work shall also be in accordance with:

   A. Installation criteria defined in these specifications and in the construction documents.
   B. Approved submittals.
   C. Applicable requirements of the referenced standards.

3.2 SUPERVISION
   The contractor shall provide the following services as part of the contract:

   A. Supervision of sub-contractors.
   B. Coordination of other contractors for system related work (electrical contractor, finish hardware contractor, door contractor, architect, and general contractor).
   C. Attend construction meetings.
D. Keep updated drawings at the site.
E. Meet construction deadlines per schedule.

3.3 PROGRAMMING
Programming of the system shall include the following tasks:
A. Programming system configuration parameters (hardware and software, door location/number, communication parameters).
B. Programming operational parameters such as unlocking/locking times, events, door shunt times, and communication failure/restore times.
C. Other programming tasks required by Owner. These additional programming requirements shall be coordinated between Owner and Contractor.

3.4 TESTING
A. Operational Testing: The contractor shall perform thorough operational testing and verify that all system components are fully operational.
B. Hard-copy System Printout: The contractor shall submit a hard-copy system printout of all components tested and certify 100 percent operation indicating all devices/panels/units have passed the test criteria set forth by the manufacturer.
C. Acceptance Test Plan Form: An Acceptance Test Plan Form shall be prepared/provided by the contractor prior to the acceptance walk through.
D. This form shall include separate sections for each device/panel/unit as well as a column indicating the manufacturer’s performance allowance/margin, a column indicating the result of the testing performed by the contractor (pass/fail), and an empty column for recording findings during the walk-through.

3.5 COMMISSIONING
The Contractor shall certify completion in writing and schedule the commissioning walk-through. The contractor shall provide all the tools and personal needed to conduct an efficient commissioning process.

3.6 TRAINING
Contractor shall provide up to three (3) hours of onsite training which shall include training on the proper installation and programming of all related hardware and software and include training of departmental end-user.
Appendix

1. Equipment Schedule

- Room T217 iStar Panel Location
  1- Sensormatic iStar pro panel to include:
    1- I-Star Pro General Controller Module (GCM II)
    2- I-Star Pro 8 Reader Add-on Access Control Module (ACM II)
    1- Sensormatic I-Star Enclosure
  Additional Required Equipment:
    1- Altronix MAXIM3D power supply or equivalent
    4- 12VDC @ 7 Amp-Hour Battery
    1-Tripp-Lite Model#IBAR4 or equivalent surge suppressor
    1- 50’ RJ-45 Ethernet cable (Cat 5 or better)

- Telecommunications Room P005 (CR) Type 1.30
  1- Mercury card reader
  1- Sensormatic RM-4 personality module
  1- Electric door strike with latchbolt status switch
  1- Door status switch (DSM)
  1- Request to exit motion detector
  1- Door Ajar Sounder

- Academic Record Storage Room 004 (CR) Type 1.30
  1- Mercury card reader
  1- Sensormatic RM-4 personality module
  1- Electric door strike with latchbolt status switch
  1- Door status switch (DSM)
  1- Request to exit motion detector
  1- Door Ajar Sounder

- Server Room 034 (CR) Type 1.30
  1- Mercury card reader
  1- Sensormatic RM-4 personality module
  1- Electric door strike with latchbolt status switch
  1- Door status switch (DSM)
  1- Request to exit motion detector
  1- Door Ajar Sounder

- Vestibule F101 (CR) Type 2.00ADA
  1- Mercury card reader
  1- Mercury weather hood
  1- Sensormatic RM-4 personality module
  2- Electric latch retraction with latch bolt monitoring
  1- Electric latch retraction power supply
  2- Door status switches
  1- Door ajar sounder
  1- Request to exit motion detector
  1- Handicapped Opener Interface

- Vestibule F102 (CR) Type 2.00ADA
  1- Mercury card reader
  1- Mercury weather hood
  1- Sensormatic RM-4 personality module
  2- Electric latch retraction with latch bolt monitoring
  1- Electric latch retraction power supply
  2- Door status switches
  1- Door ajar sounder
1- Request to exit motion detector
1- Handicapped Opener Interface

- Vestibule F102 (EL) **Type 2.33**
  2- Electric latch retraction with latch bolt monitoring
  1- Electric latch retraction power supply
  2- Door status switches
  1- Request to exit motion detector

- Stair B Z102 F101.2 (DSM) **Type 1.10**
  1- Door ajar sounder
  1- Door status switch
  1- Request to exit switch

- Vestibule F105 (CR) **Type 2.00ADA**
  1- Mercury card reader
  1- Mercury weather hood
  1- Sensormatic RM-4 personality module
  2- Electric latch retraction with latch bolt monitoring
  1- Electric latch retraction power supply
  2- Door status switches
  1- Door ajar sounder
  1- Request to exit motion detector
  1- Handicapped Opener Interface

- Vestibule F105 (EL) **Type 1.40**
  1- Electric latch retraction with latch bolt monitoring
  1- Electric latch retraction power supply
  1- Door status switch
  1- Request to exit motion detector

- Conference/Classroom Room 116 (DSM) **Type 2.10**
  1- Door ajar sounder
  2- Door status switches
  1- Request to exit switch

- Telecommunications Room T217 (CR) **Type 1.30**
  1- Mercury card reader
  1- Sensormatic RM-4 personality module
  1- Electric door strike with latchbolt status switch
  1- Door status switch (DSM)
  1- Request to exit motion detector
  1- Door Ajar Sounder

- Secure Data Storage Room 305 (CR) **Type 1.30**
  1- Mercury card reader
  1- Sensormatic RM-4 personality module
  1- Electric door strike with latchbolt status switch
  1- Door status switch (DSM)
  1- Request to exit motion detector
  1- Door Ajar Sounder
### Type 1.10 W/ Sounder

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Feed Wire Type</th>
<th>Mounting</th>
</tr>
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<tbody>
<tr>
<td>DSM</td>
<td>Door Status Monitor</td>
<td>2C/18 AWG</td>
<td>Recessed or Surface Mounted</td>
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<tr>
<td>REX</td>
<td>Request to Exit</td>
<td>4C/18 AWG SHELDED (TO ISTAR), CONNECT DSM AT DAS</td>
<td>Surface Mount on Wall or Ceiling</td>
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<td>DAS</td>
<td>Door Alarm Sounder</td>
<td>4C/18 AWG</td>
<td>Flush Mount on a Single-Gang Box</td>
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NOTE: IF CONDUIT IS REQUIRED, SIZE AS REQUIRED TO ACCOMMODATE CABLES. 3/4" MINIMUM

**Type 1.10**
Type 1.40 EL

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<th>Symbol</th>
<th>Description</th>
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<th>Mounting</th>
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</thead>
<tbody>
<tr>
<td>DSM</td>
<td>Door Status Monitor</td>
<td>2/C 22 AWG</td>
<td>Recessed or Surface</td>
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<tr>
<td>EL</td>
<td>ELECTRIC LATCH RETRACTION WITH BUILT-IN REQUEST TO EXIT SWITCH</td>
<td>EL 2/C 16 AWG - RX 2/C 22 AWG</td>
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</tr>
<tr>
<td>DAS</td>
<td>DOOR AJAR SOUNDER</td>
<td>2/C 18 AWG</td>
<td>FLUSH</td>
</tr>
<tr>
<td>J-BOX</td>
<td>JUNCTION BOX/ FUTURE SENSORMATIC RM-4 CIRCUIT BOARD ENCLOSURE</td>
<td>2 PAIR 18 GAUGE INDIVIDUALLY SHEILED</td>
<td>8 INCH SQUARE ENCLOSURE MOUNTED IN AN ACCESSIBLE SPACE ON SECURED SIDE OF DOOR</td>
</tr>
<tr>
<td>PT</td>
<td>POWER TRANSFER DEVICE</td>
<td>4 CONDUCTOR MINIMUN</td>
<td>RECESSSED</td>
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</tbody>
</table>

NOTE: IF CONDUIT IS REQUIRED, SIZE AS REQUIRED TO ACCOMANDATE CABLES. 3/4" EMT MINIMUM
TYPE 2.10 DSM

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<th>Feed Wire Type</th>
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<tr>
<td>DSM</td>
<td>Door Status Monitor</td>
<td>4/C 18AWG</td>
<td>Recessed or Surface</td>
</tr>
<tr>
<td>REX</td>
<td>Request to Exit</td>
<td>4/C 18AWG</td>
<td>Surface</td>
</tr>
<tr>
<td>DAS</td>
<td>Door Ajar Sounder</td>
<td></td>
<td>Flush</td>
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### Type 2.33 ELECTRIC LOCKING (DOGging)

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<th>Mounting</th>
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</thead>
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<tr>
<td>DSM</td>
<td>Door Status Monitor</td>
<td>1 Pair 18 Gauge</td>
<td>Recessed or Surface</td>
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<tr>
<td>EL</td>
<td>ELECTRIC LATCH RETRACTION WITH BUILT-IN REQUEST TO EXIT SWITCH</td>
<td>1 PAIR 16 GAUGE</td>
<td></td>
</tr>
<tr>
<td>DAS</td>
<td>DOOR AJAR SOUNDER</td>
<td>2/C 18AWG</td>
<td>RECESSED</td>
</tr>
<tr>
<td>RM-4 ENCLOSURE</td>
<td>SENSORMATIC RM-4 CIRCUIT BOARD ENCLOSURE</td>
<td>2 PAIR 18 GAUGE INDIVIDUALLY SHIELDED</td>
<td>8 INCH SQUARE ENCLOSURE MOUNTED IN AN ACCESSABLE SPACE ON SECURED SIDE OF DOOR</td>
</tr>
<tr>
<td>PT</td>
<td>POWER TRANSFER DEVICE</td>
<td>4 CONDUCTOR MINIMUM</td>
<td>RECESSED</td>
</tr>
</tbody>
</table>

**NOTE:** IF CONDUIT IS REQUIRED, SIZE AS REQUIRED TO ACCOMMODATE CABLES. 3/4" EMT MINIMUM

**Type 2.33 EL**
3. Materials Supplied by Others

1. Electrical Contractor
   a. Conduits from accessible space in ceiling to power transfer units located on doorjamb.
   b. Conduits from accessible space in ceiling to a single-gang electrical box for card readers.
   c. Conduits from accessible space in ceiling to a horizontally mounted single-gang electrical box centered above door for request to exit motion detector. Only where required.
   d. Conduit from accessible space in ceiling to a single-gang electrical box for door-ajar sounders.
   e. 120 VAC N/E electric power for electric latch retraction power supplies.
   f. 120 VAC N/E electric power electric room T217 at the access control panel.
   g. CAT5 cable from access control panel to SecLAN switch.

4. Building Drawings
   See drawing

END OF SECTION 28 13 00
SECTION 28 16 00 - INTRUSION DETECTION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Introduction

The Contractor shall provide, install, and program a functionally complete burglar alarm system per Manufacturer’s guidelines, codes, described, and these specifications.

1.2 WORK INCLUDED UNDER THIS SECTION

A. Installation of security system including:
   1. One (1) Bosch/Radionics D7412 control panel.
   2. One (1) Octo-popit point expansion module
   3. One (1) keypad.
   4. Seven (7) Tamper wires with 1/8” male mono-phono jack installed at projector for ceiling projectors.
   5. Three (3) Minatronics Lightgard II fiber-optic alarms for podiums.

B. System wiring

   • Wire gauge and shielding shall follow the manufacture’s installation guidelines.
   • All wiring shall be installed in accordance with the National Electric Code (NEC) and the National Fire Protection Agency (NFPA).
   • All wiring shall be concealed where possible. All exposed wiring shall be installed in a protective housing such as conduit, or Wiremold.
   • Cables penetrating floors and firewalls must be routed through a metallic sleeve and properly fire stopped to meet national and local fire codes. All walls and floors shall maintain their existing fire rating.

C. System programming

   • The Contractor shall complete the programming of security system
   • The Contractor shall not data lock the alarm control panel to prevent University personnel or any University authorized vendor from editing or revising the programming.

1.3 RELATED WORK SPECIFIED UNDER OTHER SECTIONS OF THESE SPECIFICATIONS (RELATED SECTIONS)

A. This work shall be done in strict accordance with these Contract Documents prepared for The Pennsylvania State University, Owner.

B. The Contractor shall perform all work described in this document and not expressly mentioned in the specifications, but obviously necessary for the proper execution of the same. It is not the intent to delineate or describe every detail and feature of work. No additions to the contract sum will be approved for any materials, equipment, and/or labor to perform work
hereunder unless it can be clearly shown to be beyond the scope and intent of the drawings and specifications and absolutely essential to the proper prosecution of the work.

C. Work under this contract consists of the complete installation and includes, but is not necessarily limited to, the furnishing of all labor, superintendence, material, tools, and equipment necessary to complete all the work as specified hereinafter.

1.4 GENERAL CONDITIONS

A. Submittals at bid time

For bid evaluation, bid submittals shall include one (1) set of the items described below:

1. Specification sheets (cut sheets) of all proposed equipment.
2. Equipment list identifying:
   a. Model number of each unit.
   b. Quantities of each type of device.
   c. Unit costs
3. Specification compliance: A letter submitted with the bid, responding to specification subsections individually, indicating exceptions, substitutions, and alternatives. The Contractor shall submit requests for substitutions (as well as all relevant technical data pertaining to substituted equipment) to the specifier 10 days prior to the close of bid for evaluation and approval.

B. Documentation to be submitted by Contractor after award of contract

1. Drawings: Shop drawings to provide details of proposed system and the work to be provided. These include point-to-point drawings of systems and wiring diagrams of individual devices.
2. Permits: The Contractor shall be responsible for identifying requirements for permits from all building, police, and fire authorities for the installation of the system(s) specified herein and shall assist the owner in obtaining the relevant permits.

C. Documentation to be submitted by Contractor upon completion of system installation

1. “As-builts” Upon completion of installation, the Contractor shall prepare “as-built” drawings of the system. These “As-builts” shall be AutoCAD (Revision 14 or greater) drawings of each floor plan indicating exact device locations, panel terminations, cable routes, and wire numbers as tagged and color-coded on the cable tag.

   Additionally, final point-to-point wiring diagrams of each type of device (in AutoCAD) shall be included in the “as-builts.”

   “As-builts” shall be submitted to the Owner for approval prior to the system acceptance walk through.

2. Operation and maintenance manuals: One (1) set of operating manuals shall be provided explaining the operation and maintenance of the system.
3. Paperwork to be placed inside of alarm panel:
   - Panel programming and installation manual
   - Power supply manuals
   - System operation manual (if owner is unknown)
   - Component manuals to include, keypads, motion detectors, smoke detectors, etc.
D. On-site security personnel training

Upon completion of the installation, the Contractor shall furnish training in the complete operation of the system.

E. System approvals

1. The system shall be the standard product of one manufacturer, and the manufacturer shall have been in business manufacturing similar products for at least 5 years.

2. After-sales support: The Contractor shall be a factory-authorized and trained dealer of the system and shall be factory-trained and certified to maintain/repair the system after system acceptance.

F. Quality assurance

1. All equipment, systems, and materials furnished and installed under this section shall be installed in accordance with the applicable standards of:
   a. National codes: NEC and NFPA
   b. Approvals and Listings: UL
   c. Pennsylvania Department of Labor and Industry
   d. EIA/TIA Telecommunications wiring standards
   e. Local Authorities Having Jurisdiction

G. Guarantee of Work

All components, parts, and assemblies supplied by the Manufacturers and installed by the Contractor shall be warranted against defects in material and workmanship for a period of at least 12 months (parts and labor), commencing upon date of acceptance by Owner. A qualified factory-trained service representative shall provide warranty service.

H. Service/Maintenance

1. During the warranty period the Contractor shall be responsible for maintenance and repair of the system including the repair of workmanship defects, free of charge (parts and labor).

2. The installer shall correct any system defect within six (6) hours of receipt of call from Owner.

3. The Contractor shall offer extended service/maintenance agreements up to four years after the warranty expires. The agreement shall be renewable monthly, quarterly, or yearly.

I. Building Security

Building security shall remain functional during installation. Doors and door locking shall remain operational. University Police must be notified if it is not possible to lock the doors at the end of each workday. Failure to comply will result in removal from the approved vendor list.

PART 2 - Security System

2.1 SECURITY SYSTEM

A. Security System Description

Bosch/Radionics D7412 control panel.
B. Security System Feature/Capability

The following indicates system capabilities and capacities:

1. Minimum of seventy-five (75) points and eight (8) partitions.
2. Standby power capable of maintaining system operation for a minimum of 12 hours and the ability to transmit a trouble signal before failure.
3. A digital communicator capable of communicating with a Bosch/Radionics D6600 central station receiver.

C. Security System Interface Requirements

1. All Installations: The security system shall be installed in accordance with the National Electric Code and the Local Authority Having Jurisdiction.
2. The security control hardware shall be installed in accordance with UL requirements.

2.2 SECURITY SYSTEM MATERIALS

A. Security System Hardware Description

1. Security System: The security system shall be provided, at a minimum, with the following components. Additional accessories shall be provided based on the quantities and features required for the application.
   a. Bosch/Radionics D7412 panel with enclosure.
      • System Accessories:
        1) AC power supply
        2) Conettix DX4020 Ethernet Network Interface Module
        3) Minimum: 7 amp hour battery back up
        4) Panel tamper switch
   2. One (1) Bosch octo-popit point expansion module
   3. One (1) Bosch/Radionics D1255 keypad
   4. Seven (7) Ceiling projector tamper wires with 1/8” male mono-phone jacks
   5. Three (3) Minatronics LightGard II Fiber Optic Cable Security Boxes
      http://www.minatronics.com/

2.3 SECURITY SYSTEM EQUIPMENT LOCATIONS

A. Bosch D7412 intrusion alarm panel, room T217
   1. Bosch D1255 keypad, room 102 outside entrance door
   2. Lightgard II, podiums room 022, 102, 102A
   3. Projector tamper wires, room (4) 022, (2) 102, (2) 102A

PART 3 - Execution

3.1 INSTALLATION

Install all equipment and materials in accordance with the “current” recommendations of the manufacturer. The work shall also be in accordance with:

A. Installation criteria defined in these specifications and in the construction documents.
B. Approved submittals.
C. Applicable requirements of the referenced standards.
3.2 **SUPERVISION**
The contractor shall provide the following services as part of the contract:

A. Supervision of sub-contractors.

B. Coordination of other contractors for system related work (electrical contractor, finish hardware contractor, door contractor, architect, and general contractor).

C. Attending construction meetings.

D. Keeping updated drawings at the site.

E. Meeting construction deadlines per schedule.

3.3 **PROGRAMMING**
Programming of the system shall include the following tasks:

A. Programming system configuration parameters (hardware and software, door location/number, communication parameters).

B. Programming operational parameters such as arm/disarm combinations, entry/exit delay times, and communication failure/restore times.

C. Other programming tasks required by the Owner. These additional programming requirements shall be coordinated between the Owner and the Contractor.

3.4 **TESTING**

A. Operational Testing: The contractor shall perform thorough operational testing and verify that all system components are fully operational.

B. Hard-copy System Printout: The contractor shall submit a hard-copy system printout of all components tested and certify 100 percent operation indicating all devices/panels/units have passed the test criteria set forth by the manufacturer.

C. Acceptance Test Plan Form: An acceptance test plan form shall be prepared/provided by the contractor prior to the acceptance walk through.

D. This form shall include separate sections for each device/panel/unit as well as a column indicating the manufacturer's performance allowance/margin, a column indicating the result of the testing performed by the contractor (pass/fail), and an empty column for recording finding during the walk-through.

3.5 **COMMISSIONING**
The Contractor shall certify completion in writing and schedule the commissioning walk-through. The contractor shall provide all the tools and personal needed to conduct an efficient commissioning process.
3.6 TRAINING

Up to one hour of on site training shall be provided which shall include training on the use of the system to the departmental end-user.

Appendix

1. Zone List

Partition 1 - Account # (provided at time of installation)
1. Panel tamper (24 hr silent alarm)
2. Room 022 ceiling projector
3. Room 022 ceiling projector
4. Room 022 ceiling projector
5. Room 022 podium
6. Room 102 ceiling projector
7. Room 102 ceiling projector
8. Room 102 podium
9. Room 102A ceiling projector
10. Room 102A ceiling projector
11. Room 102A podium

2. Material Supplied by Others

1. OTC
   a. A dedicated VOIP to analog telephone line in room T217 adjacent to security panel for central station communications.

2. OPP CCS
   a. Security LAN connection for security panel for central station communications.

END OF SECTION 28 1600
SECTION 28 23 00 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Introduction

The Contractor shall provide, install, and program a functionally complete video surveillance system per Manufacturer’s guidelines, codes, described, and these specifications.

1.2 WORK INCLUDED UNDER THIS SECTION

A. Installation of Closed Circuit Television system including:

1. Eleven (11) IP video cameras
2. One (1) network video recorder (NVR)
3. One (1) 24 port POE (Power Over Ethernet) Ethernet switch
4. One (1) camera power supply

B. System wiring

- All system wiring shall be plenum rated.
- Video transmission cable shall be plenum rated Cat 5e or greater for all camera runs. Lengths exceeding 300' will require repeaters or other methods of transmission.
- Wire gauge and shielding shall follow the manufacture’s installation guidelines.
- All wiring shall be installed in accordance with the National Electric Code (NEC) and the National Fire Protection Agency (NFPA).
- All wiring shall be concealed where possible. All exposed wiring shall be installed in a protective metallic housing such as conduit, or Wiremold.
- Cables penetrating floors and firewalls must be routed through a metallic sleeve and properly fire stopped to meet national and local fire codes. All walls and floors shall maintain their existing fire rating.

C. System programming

- The Contractor shall complete the initial programming of the network video recorder
- The Contractor shall adjust cameras (aim and focus) and verify with customer that the field of view is acceptable.
- The Contractor shall not data lock any of the security equipment to prevent University personnel or any University authorized vendor from editing or revising the programming.

D. Related work specified under other sections of these specifications (Related sections)

1. A. This work shall be done in strict accordance with these Contract Documents prepared for The Pennsylvania State University, Owner.
2. B. The Contractor shall perform all work described in this document and not expressly mentioned in the specifications, but obviously necessary for the proper execution of the same. It is not the intent to delineate or describe every detail and feature of work. No additions to the contract sum will be approved for any materials, equipment, and/or labor to perform work hereunder unless it can be clearly shown to be beyond the scope and
intent of the drawings and specifications and absolutely essential to the proper prosecution of the work.

3. Work under this contract consists of the complete installation and includes, but is not necessarily limited to, the furnishing of all labor, superintendence, material, tools, and equipment necessary to complete all the work as specified hereinafter.

1.3 GENERAL CONDITIONS

A. Submittals at bid time

For bid evaluation, bid submittals shall include (1) set of the items described below:

1. Specification sheets (cut sheets) of all proposed equipment.
2. Equipment list identifying:
   - Model number of each unit.
   - Quantities of each type of device.
   - Unit costs
3. Specification compliance: A letter submitted with the bid, responding to specification subsections individually, indicating exceptions, substitutions, and alternatives. The Contractor shall submit requests for substitutions (as well as all relevant technical data pertaining to substituted equipment) to the specifier 10 days prior to the close of bid for evaluation and approval.

B. Documentation to be submitted by Contractor after award of contract

1. Drawings: Shop drawings to provide details of proposed system and the work to be provided. These include point-to-point drawings of systems and wiring diagrams of individual devices.
2. Permits: The Contractor shall be responsible for identifying requirements for permits from all building, police, and fire authorities for the installation of the system(s) specified herein and shall assist the owner in obtaining the relevant permits.

C. Documentation to be submitted by Contractor upon completion of system installation

1. “As-builts”: Upon completion of installation, the Contractor shall prepare “as-built” drawings of the system. These “As-builts” shall be AutoCAD (Revision 14 or greater) drawings of each floor plan indicating exact device locations, panel terminations, cable routes, and wire numbers as tagged and color-coded on the cable tag. Additionally, final point-to-point wiring diagrams of each type of device (in AutoCAD) shall be included in the “as-builts.”

   “As-builts” shall be submitted to the Owner for approval prior to the system acceptance walk through.

2. Operation and maintenance manuals: One (1) set of operating manuals shall be provided explaining the operation and maintenance of the system.
3. Required security paperwork:
   - DVR installation and operation manual
   - Hardware manuals, to include cameras and power supplies
   - Wiring notes with equipment locations

D. On-site security personnel training

Upon completion of the installation, the Contractor shall furnish training in the complete operation of the system.
E. System approvals
1. The system shall be the standard product of one manufacturer, and the manufacturer shall have been in business manufacturing similar products for at least 5 years.
2. After-sales support: The Contractor shall be a factory-authorized and trained dealer of the system and shall be factory-trained and certified to maintain/repair the system after system acceptance.

F. Quality assurance
1. All equipment, systems, and materials furnished and installed under this section shall be installed in accordance with the applicable standards of:
   a. National codes: NEC and NFPA
   b. Approvals and Listings: UL
   c. Pennsylvania Department of Labor and Industry
   d. EIA/TIA Telecommunications wiring standards
   e. Local Authorities Having Jurisdiction

G. Guarantee of Work
All components, parts, and assemblies supplied by the Manufacturers and installed by the Contractor shall be warranted against defects in material and workmanship for a period of at least 12 months (parts and labor), commencing upon date of acceptance by Owner. A qualified factory-trained service representative shall provide warranty service.

H. Service/Maintenance
1. During the warranty period the Contractor shall be responsible for maintenance and repair of the system including the repair of workmanship defects, free of charge (parts and labor).
2. The installer shall correct any system defect within six (6) hours of receipt of call from Owner.
3. The Contractor shall offer extended service/maintenance agreements up to four years after the warranty expires. The agreement shall be renewable monthly, quarterly, or yearly.

I. Building Security
Building security shall remain functional during installation. Doors and door locking shall remain operational. University Police must be notified if it is not possible to lock the doors at the end of each workday. Failure to comply will result in removal from the approved vendor list.

PART 2 - CLOSED CIRCUIT TELEVISION (CCTV)

2.1 CCTV

A. CCTV Description
The following specifications are provided to establish minimum installation and operational requirements for the proposed video surveillance system. The University will consider and must approve reasonable alternatives that are proposed for any element or component or the proposed system.

The Bidder will provide as part of the Quotation documentation the Manufacturers Specifications for each component to be included in the Quote. A quotation without proper documentation will not be considered.
B. CCTV Feature/Capability
1. Cameras shall be high resolution color day/night mini dome IP cameras
2. Cameras shall have a minimum of at least 1.3 megapixels of resolution
3. Cameras shall be equipped with lenses that have an automatic iris and a variable focal length of 4 to 8 millimeters
4. Camera housings shall be vandal resistant
5. Exterior cameras shall be pendant mounted
6. Exterior cameras shall include integral infrared illumination.

C. CCTV Requirements
1. The CCTV equipment shall be installed in accordance with the National Electric Code and the Local Authority Having Jurisdiction.
2. The CCTV equipment hardware shall be installed in accordance with UL requirements.

2.2 CCTV MATERIALS

A. CCTV Camera
1. AXIS 216MFD-V Network Camera

B. Additional Equipment
1. 24 Port POE Ethernet switch

2.3 CCTV EQUIPMENT LOCATIONS

<table>
<thead>
<tr>
<th>Henderson Bridge Replacement Equipment Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Device Location</strong></td>
</tr>
<tr>
<td>Room T217</td>
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<tr>
<td>Room T217</td>
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<tr>
<td>Lobby F001</td>
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<tr>
<td>Vestibule F101 (Exterior)</td>
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<tr>
<td>Vestibule F101 (Interior)</td>
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<tr>
<td>Vestibule F102 (Exterior)</td>
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<td>Vestibule F102 (Interior)</td>
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<td>Lobby F104</td>
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<tr>
<td>Vestibule F105 (Exterior)</td>
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<tr>
<td>Vestibule F105 (Interior)</td>
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<tr>
<td>Lobby F201</td>
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<tr>
<td>Lobby F301</td>
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<tr>
<td>Lobby F401</td>
</tr>
</tbody>
</table>

**NOTE:** Exact camera locations to be coordinated with owner at time of installation.

2.4 NETWORK VIDEO RECORDER (NVR)
Installed in room T217
A. Network Video Recorder (NVR) Description Intellex IP
1. The product specified shall be a PC-based Network Video Recorder that provides mass video storage capability by providing 1000GB or greater hard drive storage capacity, as required by the application. The NVR is designed to simultaneously record, search, play back, archive, and display composite video. Activity is detected by motion, contact inputs, or both. Pan/Tilt/Zoom control is operational via the local unit or remote workstation software.

2. A remote software program shall be supplied by the manufacturer to allow interaction with the main unit from remote workstations via a 10/100/1000 Base-T Ethernet network connection. The remote software program shall be capable of viewing live or recorded video and P/T/Z camera control.

3. The NVR shall be compatible with the Software House C*Cure 800/9000 Security Management System

B. NVR Feature/Capability Summary
1. The system shall consist of a PC-based network video recorder unit, PC mouse and keyboard. The recorder is supplied with a DVD/CD-RW drive. Administrator or User programming and control shall be accomplished via a Graphical User Interface displayed on a customer supplied SVGA monitor. NVR shall be capable of remote viewing and playback of video via TCP/IP communications

2. The NVR specified shall be capable of recording at system frame rate of 480 images per second (ips) or greater, as required by the application.

3. Security shall be provided via fully definable users that may be granted or denied access to system administration functions, recorded video, PTZ camera control, and live viewing of video. Activities to the recorder such as alarm events, motion, video loss, etc. shall be maintained in a user event log.

4. A local smart motion search function of the specified recorder shall allow recorded video to be searched for motion activity in any area of the recorded video images and produce search results accordingly.

5. Each camera shall be independently programmable for alarm inputs, motion detection, and recording rates so that customized or specialized requirements may be met. Scheduled recording by time, day, motion and alarms may also be programmed. Video recording shall be easily searched by time, date, motion, or alarms based upon a color-coded scheme search. Searching the recorded video using this color-coded scheme feature shall be provided in the local recorder and via the remote viewer workstation software.

6. The recorder shall provide simultaneous recording of live video while the operator is viewing the playback of recorded video.

7. The recorder shall provide a full screen or multi-screen display of any camera inputs selectable with or without the GUI displayed.

8. In addition to the standard post alarm or motion detection recording, the recorder shall allow selection of 5 seconds of pre-alarm recording from an alarm(s) input or upon motion detection. Five configurable motion detection zones per camera shall be programmable.

9. The manufacturer shall include a remote viewing software program that operates in a remote PC workstation running Windows NT 4.0 SP6, Windows 2000 Pro SP3, Windows XP Pro or Windows 7. This remote software allows access to viewing live images as well as the recorded images stored in the specified video recorder. Recorded images may be viewed based upon time, date, motion, or alarms. The remote viewer software shall include Graphical User Interface (GUI) software to allow access via an Ethernet network connection to live and recorded video.
PART 3 - EXECUTION

3.1 INSTALLATION
Install all equipment and materials in accordance with the “current” recommendations of the manufacturer. The work shall also be in accordance with:

A. Installation criteria defined in these specifications and in the construction documents.
B. Approved submittals.
C. Applicable requirements of the referenced standards.

3.2 SUPERVISION
The contractor shall provide the following services as part of the contract:

A. Supervision of sub-contractors.
B. Coordination of other contractors for system related work (electrical contractor, finish hardware contractor, door contractor, architect, and general contractor).
C. Attending construction meetings.
D. Keeping updated drawings at the site.
E. Meeting construction deadlines per schedule.

3.3 PROGRAMMING
Programming of the system shall include the following tasks:

A. Programming system configuration parameters (hardware and software, camera location/number, communication parameters).
B. Other programming tasks required by the Owner. These additional programming requirements shall be coordinated between the Owner and the Contractor.

3.4 TESTING

A. Operational Testing: The contractor shall perform thorough operational testing and verify that all system components are fully operational.
B. Hard-copy System Printout: The contractor shall submit a hard-copy system printout of all components tested and certify 100 percent operation indicating all devices/panels/units have passed the test criteria set forth by the manufacturer.
C. Acceptance Test Plan Form: An acceptance test plan form shall be prepared/provided by the contractor prior to the acceptance walk through.
D. This form shall include separate sections for each device/panel/unit as well as a column indicating the manufacturer’s performance allowance/margin, a column indicating the result of
the testing performed by the contractor (pass/fail), and an empty column for recording finding during the walk-through.

3.5 COMMISSIONING
The Contractor shall certify completion in writing and schedule the commissioning walk-through. The contractor shall provide all the tools and personal needed to conduct an efficient commissioning process.

3.6 TRAINING
Up to three hours of on site training shall be provided which shall include training on the proper installation and programming of all related hardware and software and training of departmental end-user.

END OF SECTION 28 2300
SECTION 28 31 11 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary
   Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Fire-alarm control unit.
   3. System smoke detectors.
   4. Nonsystem smoke detectors.
   5. Heat detectors.
   7. Magnetic door holders.
   10. Digital alarm communicator transmitter.
   11. System printer.

1.3 DEFINITIONS

A. LED: Light-emitting diode.


1.4 SYSTEM DESCRIPTION

A. Noncoded, UL-certified addressable system, with multiplexed signal transmission, dedicated to
   fire-alarm service only.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and
   attachments to other work.
   1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of
      Fire Alarm Systems" Chapter in NFPA 72.
   2. Include voltage drop calculations for notification appliance circuits.
   3. Include battery-size calculations.
   4. Include performance parameters and installation details for each detector, verifying that
      each detector is listed for complete range of air velocity, temperature, and humidity
      possible when air-handling system is operating.
   5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts,
      drawn to scale and coordinating installation of duct smoke detectors and access to them.
      Show critical dimensions that relate to placement and support of sampling tubes, detector
      housing, and remote status and alarm indicators. Locate detectors according to
      manufacturer's written recommendations.
6. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

C. General Submittal Requirements:
1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
   a. Trained and certified by manufacturer in fire-alarm system design.
   b. NICET-certified fire-alarm technician, Level III minimum.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
   2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
   3. Record copy of site-specific software.
   4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
      a. Frequency of testing of installed components.
      b. Frequency of inspection of installed components.
      c. Requirements and recommendations related to results of maintenance.
      d. Manufacturer's user training manuals.
   5. Manufacturer's required maintenance related to system warranty requirements.
   6. Abbreviated operating instructions for mounting at fire-alarm control unit.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
   2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
   3. Smoke Detectors, Heat Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
   4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
   5. Keys and Tools: One extra set for access to locked and tamperproofed components.
   6. Audible and Visual Notification Appliances: One of each type installed.
   7. Fuses: Two of each type installed in the system.
1.8 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.

E. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

F. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FMG-approved alarm company.

1.9 PROJECT CONDITIONS

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
   1. Notify Construction Manager no fewer than 7 days in advance of proposed interruption of fire-alarm service.
   2. Do not proceed with interruption of fire-alarm service without Construction Manager's written permission.

1.10 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.11 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
   1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Provide Siemens MXL system with CMI300 modem per University Standards.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
   2. Heat detectors.
   3. Smoke detectors.
   4. Duct smoke detectors.
   5. Verified automatic alarm operation of smoke detectors.
   6. Automatic sprinkler system water flow.
   7. Heat detectors in elevator shaft and pit.

B. Fire-alarm signal shall initiate the following actions:
   1. Transmit an alarm signal to University Fire Command Center.
   2. Continuously operate alarm notification appliances.
   3. Identify alarm at fire-alarm control unit and remote annunciators.
   4. Unlock electric door locks in designated egress paths.
   5. Release fire and smoke doors held open by magnetic door holders.
   6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
   7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
   8. Recall elevators to primary or alternate recall floors.
   9. Activate emergency lighting control.
   10. Activate emergency shutoffs for gas and fuel supplies.
   11. Record events in the system memory.
   12. Record events by the system printer.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:
   1. Valve supervisory switch.
   2. Low-air-pressure switch of a dry-pipe sprinkler system.
   3. Elevator shunt-trip supervision.

D. System trouble signal initiation shall be by one or more of the following devices and actions:
   1. Open circuits, shorts, and grounds in designated circuits.
   2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
   3. Loss of primary power at fire-alarm control unit.
   4. Ground or a single break in fire-alarm control unit internal circuits.
   5. Abnormal ac voltage at fire-alarm control unit.
   7. Failure of battery charging.
   8. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer.

2.3 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
   a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
   b. Include a real-time clock for time annotation of events on the event recorder and printer.
2. Addressable initiation devices that communicate device identity and status.
   a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
   b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: Liquid-crystal type, 3 line(s) of 40 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:
1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.
   a. Initiating Device Circuits: Style B.
   b. Notification Appliance Circuits: Style Y.
   d. Install no more than 50 addressable devices on each signaling line circuit.

D. Smoke-Alarm Verification:
1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

E. Elevator Recall:
1. Smoke detectors at the following locations shall initiate automatic elevator recall.
   a. Elevator lobby detectors except the lobby detector on the designated floor.
   b. Smoke detector in elevator machine room.
   c. Smoke detectors in elevator hoistway.
2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
   a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

F. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
G. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

H. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

I. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

J. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
   1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

K. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

L. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
   1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
   2. Station Reset: Key- or wrench-operated switch.
   3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:
   1. Comply with UL 268; operating at 24-V dc, nominal.
   2. Detectors shall be four-wire type.
   3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
   4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. **Self-Restoring:** Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

6. **Integral Visual-Indicating Light:** LED type indicating detector has operated and power-on status.

7. **Remote Control:** Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
   a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
   b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
   c. Provide multiple levels of detection sensitivity for each sensor.

**B. Photoelectric Smoke Detectors:**

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

**C. Duct Smoke Detectors:** Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.

4. Each sensor shall have multiple levels of detection sensitivity.

5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.


### 2.6 HEAT DETECTORS

**A. General Requirements for Heat Detectors:** Comply with UL 521.

**B. Heat Detector, Combination Type:** Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.

2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

**C. Heat Detector, Fixed-Temperature Type:** Actuated by temperature that exceeds a fixed temperature of 190 deg F.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
   1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.
   1. Rated Light Output:
      a. 15/30/75/110 cd, selectable in the field.
   2. Mounting: Wall mounted unless otherwise indicated.
   3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
   4. Flashing shall be in a temporal pattern, synchronized with other units.
   5. Strobe Leads: Factory connected to screw terminals.

2.8 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
   1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
   2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
   3. Rating: 24-V ac or dc.

B. Material and Finish: Match door hardware.

2.9 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
   1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.10 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.
B. Integral Relay: Capable of providing a direct signal [to elevator controller to initiate elevator recall] [to circuit-breaker shunt trip for power shutdown] <Insert functions>.

2.11 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:
   1. Verification that both telephone lines are available.
   2. Programming device.
   3. LED display.
   5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:
   1. Address of the alarm-initiating device.
   2. Address of the supervisory signal.
   3. Address of the trouble-initiating device.
   4. Loss of ac supply or loss of power.
   5. Low battery.
   6. Abnormal test signal.
   7. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.12 SYSTEM PRINTER

A. Printer shall be listed and labeled by an NRTL as an integral part of fire-alarm system.

2.13 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
   1. Factory fabricated and furnished by manufacturer of device.
   2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.
B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.
   1. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
   1. Expand, modify, and supplement existing monitoring equipment as necessary to extend existing monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

D. Smoke- or Heat-Detector Spacing:
   3. Smooth ceiling spacing shall not exceed 30 feet.
   4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
   5. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
   6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

F. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

G. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

H. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

J. Device Location-Indicating Lights: Locate in public space near the device they monitor.

K. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.

L. Annunciator: Install with top of panel not more than 72 inches above the finished floor.

3.2 CONNECTIONS

A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
   1. Smoke dampers in air ducts of designated air-conditioning duct systems.
2. Alarm-initiating connection to elevator recall system and components.
3. Alarm-initiating connection to activate emergency lighting control.
4. Supervisory connections at valve supervisory switches.
5. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.4 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.5 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Tests and Inspections:
   1. Visual Inspection: Conduct visual inspection prior to testing.
      a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
      b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.


   3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

   4. Test audible appliances for the private operating mode according to manufacturer's written instructions.

   5. Test visible appliances for the public operating mode according to manufacturer's written instructions.


C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

D. Fire-alarm system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 28 31 11
SECTION 31 16 41 – SIDEWALKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for furnishing and installing reinforced cement concrete sidewalks.

B. Related Sections:
   1. Section 03 11 00: Concrete Forming.
   2. Section 03 30 53: Miscellaneous Cast-in-Place Concrete.
   3. Section 31 20 00: Earth Moving.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   3. AASHTO M 182, Standard Specification for Burlap Cloth Made from Jute or Kenaf.

B. American Society for Testing and Materials (ASTM):
   4. ASTM C 116, Fibrous Concrete Reinforcing.

1.3 SUBMITTALS

A. Submit the following information to the Engineer for approval:
   1. Shop Drawings:
      a. Working Drawings for the layout of expansion joints
      b. Working Drawings for the layout of construction joints.
   2. Samples:
      a. Subbase aggregate
   3. Quality Assurance/Control Submittals:
      a. Design Data:
         1) Concrete mix designs
      b. Certificates:
         1) Certificates of Compliance
            a) Concrete.
            b) Air-entraining admixture.
            c) Concrete reinforcement.
            d) Concrete curing compounds.
            e) Concrete curing and protecting covers.
            f) Expansion joint fillers.
            g) Stone aggregate.
1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Quality Assurance Testing and Inspection Agency Qualifications:
      a. Employ an independent quality assurance testing and inspection agency qualified
to perform the inspections and testing required by this Section.
         1) Materials and fabrication procedures are subject to inspection and testing at
            the source and the field by the independent quality assurance testing and
            inspection agency.
         2) Inspections and tests performed by the quality assurance testing and
            inspection agency do not relieve the Contractor of responsibility for
            providing materials and fabrication procedures in compliance with specified
            requirements.
      b. The independent quality assurance testing and inspection agency must conform to
         the quality standards of the nationally recognized associations and agencies that
         promulgate the test standards, particularly ASTM E 329.

   B. Certifications:
      1. Submit certified copies of test reports from the independent quality assurance testing and
         inspection agency for all analyses and tests required by the referenced AASHTO and
         ASTM Standards.
         a. Direct the independent quality assurance testing and inspection agency to submit
            certified written reports that document the results of all tests and inspections
            performed directly to the Engineer immediately after the work is performed.
            1) In the reports, state whether the tested and inspected items comply with
               specified requirements or deviate from them.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete:
   1. Portland Cement: Normal strength, Type 1A air entrained, conforming to ASTM C 150.
      a. Cement concrete shall be a minimum of six and maximum of eight 96-pound bags
         per cubic yard.
      b. Fine aggregate shall be Type A. Do not use fine aggregate produced from
         limestone in concrete wearing surfaces.
      c. Coarse aggregate shall be Type A, No. 57 as specified in PENNDOT 408, Section
         703.2 Tables B, C, and D.


C. Potable water.

D. Concrete shall have an entrained air content of 6% in the plastic state with a tolerance of +/-1.5% during the work. Entrained air in the hardened concrete shall not be less than 3.5% or
greater than 7.5%. Testing for air entrainment shall be in accordance with PENNDOT 408.

E. Concrete Forms:
   1. Furnish acceptable wood or metal forms that meet the requirements and that extend the
      full depth of the concrete.
   2. Erect forms true to line and grade. Maintain alignment using steel stakes at intervals not
      greater than 4 feet.
F. Concrete Reinforcement:
   1. Fibrous concrete reinforcing to meet ASTM C 116: Fibermesh, 4019 Industry Drive,
      Chattanooga, TN 37416, (615) 892-7243 or approved equal.

G. Expansion Joint Fillers:

H. Stone Aggregate:
   I. Crushed Stone: PENNDOT No. 2A coarse aggregate conforming to PENNDOT 408, Section
      703.2 and as specified in Part 2.3.C of Section 31 20 00: Earth Moving.

2.2 MIXES

A. Provide Class B Concrete to the following criteria and in accordance with Section 033000.
   1. Compressive strength at 28 days: 3300 psi.
   2. Slump: 3 inches.
   3. Aggregate size: 1 inch.

2.3 SOURCE QUALITY CONTROL

A. Submit Certificates of Compliance from the quality assurance testing and inspection agency
   certifying that the materials provided comply with the specified requirements.

B. Have the quality assurance testing and inspection agency perform acceptance testing of the
   stone aggregate at the source.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that previously installed protection measures are in place.

B. Verify that all surfaces abutting new concrete pavement are clean, true, and free from chips,
   etc.

C. Beginning installation means acceptance of existing conditions.

3.2 PREPARATION

A. Do not place crushed stone on soft, muddy, or frozen areas. Correct irregularities or soft areas
   before placing crushed stone.

B. Place and secure forms to correct location, dimension, and profile.

C. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

D. Proof roll prepared subbase to check for unstable areas and need for additional compaction.

E. Moisten base to minimize absorption of water from fresh concrete.
3.3 INSTALLATION OF AGGREGATE BASE

A. Maintain optimum moisture content of materials in order to attain required compaction density.

B. Spread crushed stone on prepared subgrade, in a manner not causing segregation, in locations and to attain depth shown on Drawings, after final compaction. Use acceptable equipment and methods per PENNDOT Publication 408.
   1. Compact uniformly spread crushed stone to not less than 100% of the maximum dry-weight density, which will be determined in accordance with PTM No. 106, Method B.
   2. Proceed with compaction gradually from sides to center, with each succeeding pass uniformly overlapping the previous pass. Continue until the entire area is shaped and compacted.
   3. If crushed stone does not contain sufficient moisture after placement, add water to obtain proper compaction.

C. Top surface of compacted crushed stone shall be plus or minus ¼ inch from required depth.

3.4 INSTALLATION OF CONCRETE

A. Comply with ACI recommendations when placing concrete.

B. Mix and deliver concrete in accordance with ASTM C 94-92A.
   1. Add fibrous concrete reinforcing at the rate of 1.5 pounds of fiber to 1 cubic yard of concrete or as per manufacturer’s recommendations.
   2. Use accelerating admixtures in cold weather only when approved by Owner. Use of admixtures will not relax cold weather placement requirements.
   3. Use set-retarding admixtures during hot weather only when approved by Owner.

C. Place expansion joint filler between new and existing work and as shown on drawings and secure to formwork during concrete placement.
   1. Provide joint filler abutting existing concrete, concrete curbs, catch basins, inlets, manholes, and any other fixed objects.
   2. Recess joint filler ¼ inch from top of slab.

D. Construct control and construction joints in locations indicated on the Drawings.
   1. Form control joints in fresh concrete by grooving top portion with cutting tool and finishing edges with a metal edger having a ¼-inch radius.
      a. Control joints shall have a depth of at least ¼ of the concrete thickness.
      b. Space control joints at the width of the sidewalk, 6’ maximum.
   2. Place construction joints at the end of placements and at locations where placement operations are stopped for more than ½ hour except where placements stop at expansion joints.
      a. Place expansion joints at 30’ maximum spacing.
      b. Construct joints using standard metal keyway section forms.
   3. The concrete around light standards, poles, fire hydrants, access frames, and covers to underground utilities, manhole frames and covers, and similar structures shall be scored, by edging or grooving, in a block 8 inches wider than the maximum dimensions of the structure.

E. Maintain records of concrete placement. Record date, location of pour, quantity, air temperature, and test samples taken.

F. Provide concrete pavement with a light broom finish.
G. The edges and perimeter and expansion and control joint scoring of all slabs shall be edged with a metal edger having a $\frac{1}{4}$-inch radius to produce a dense compact border outlining each slab.

3.5 CONCRETE CURING

A. Immediately after placement, protect concrete from premature drying, excessive hot or cold temperatures, and mechanical injury.
   1. Maintain concrete with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of cement and hardening of concrete.
   2. When the average daily temperature is less than 40 degrees F, maintain temperature of newly placed concrete between 50 to 70 degrees F during the required curing period.
   3. When the average daily temperature is above 70 degrees F, protect the newly placed concrete from high temperatures and drying winds by keeping the concrete surface continually wet and by providing wind breaks during the required curing period.

3.6 PROTECTION

A. Protect the walks from damage until acceptance of the work.
   1. Exclude pedestrians from walks for at least 3 days after placement.
   2. Provide necessary watchmen to prevent vandalism to freshly poured concrete walks.

3.7 FIELD QUALITY CONTROL

A. Submit samples of the subbase aggregate obtained from the construction site to the quality assurance testing and inspection agency for verification testing.

3.8 CLEANING

A. Sweep the concrete walks.

B. Wash the concrete walks so they are free of stains, graffiti, discoloration, dirt, and other foreign materials.
   1. Completely remove graffiti from graffiti-marked sidewalks.

C. Satisfactorily dispose of unsuitable and surplus materials provided under this Contract.

END OF SECTION 31 16 41
SECTION 31 20 00 - EARTH MOVING [C]

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Excavation for pavement; excavation and placement of compacted fill and backfill for structures and drainage; construction of embankments; subgrade and foundation preparation; and subsurface extraction of miscellaneous structures and facilities indicated to be removed.

B. Related Sections:
1. Section 02 41 00: Demolition.
2. Section 33 01 01: Maintenance and Support of Existing Utilities.
3. Section 31 22 00: Grading.

1.2 REFERENCES [C]

A. American Society for Testing and Materials (ASTM):
1. ASTM C 136; Test Method for sieve Analysis of Fine and Coarse Aggregates.
2. ASTM C 295; Standard Guide for Petrographic Examination of Aggregates for Concrete. [C]
3. ASTM D 422; Test Method for Particle-size Analysis of Soils.3
4. ASTM D 698; Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
5. ASTM C 1580; Test Method for Water-Soluble Sulfate in Soil. [C]
6. ASTM D 2487; Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
7. ASTM D 2922; Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth). [C]
8. ASTM D 3017; Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

B. Occupational Safety and Health Administration (OSHA).

C. Commonwealth of Pennsylvania Department of Transportation (PENNDOT)
1. Publication 408, Specifications, as supplemented
   a. PENNDOT Section 703, Aggregate
2. Publication 19, Field and Lab Test Manual
   a. PTM 519, Wet-Dry Durability Test

1.3 DEFINITIONS [C]

A. Earthwork Terminology: Terms used in this Section and not defined herein shall be interpreted in accordance with the definitions given in ASTM D 653.

B. Approved Material: Material which meets specified requirements for use as embankment, fill, or backfill.
C. Backfill: Soil or soil-rock material used to backfill excavations and to backfill excavated spaces around foundation walls, building walls, retaining walls, and abutments.

D. Borrow: Soil material used in embankment or other construction which is excavated from any location other than required onsite excavations.

E. Embankment: Soil or soil-rock material placed to raise the subgrade or natural grade of the site for embankment construction.

F. Excavation: The removing of all materials encountered within the indicated or specified limits, regardless of the nature of the material encountered and the method by which removed, and further defined in Article 1.5 below.

G. Excess Excavation: Material excavated beyond or below cross section shown, as well as unavoidable overbreakage in rock.

H. Imported Material: Soil or granular material which is hauled in from off-site areas.

I. Optimum Moisture Content: The water content at which a soil can be compacted to a maximum dry unit weight by a given compactive effort.

J. Relative Compaction: The ratio, expressed as a percentage, of the in-place dry density of fill material as compacted in the field to the maximum dry density of the same material as determined by laboratory test ASTM D 698, Method D.

K. Soil Classification: Soil classification is based on the Unified Soil Classification system given in ASTM D 2487. Group symbols, when used, conform with the symbols of ASTM D 2487.

L. Subgrade: Subgrade is the lowest elevation of excavation and the highest elevation of embankment required to accommodate the indicated construction.

M. Unsuitable Material: Excavated material or material below the natural ground surface in embankment areas or below subgrade elevation in excavated areas, which is unsuitable for its planned use as determined by the Engineer. Unsuitable material is further defined as material determined to be:
   1. Of such unstable nature as to be incapable of being compacted to specified density using ordinary methods at optimum moisture content; or
   2. Too wet to be properly compacted and circumstances prevent suitable in-place drying prior to incorporation into the work; or
   3. Potentially expansive material such as mine tailings, pyritic shale and slag. All fill and backfill materials shall have less than 0.1% total sulfur by weight as determined by ASTM D 4239. Suspected expansive shale should additionally be subjected to wet-dry durability testing in accordance with PENNDOT PTM 519. Final determination of expansive potential will be at the discretion of the geotechnical engineer-of-record; or
   4. Otherwise unsuitable for the planned use.

1.4 QUALITY ASSURANCE

A. Inspections and Tests: The Contractor shall provide quality control inspections and tests as specified under Article 3.14 to assure compliance with specified requirements.

B. Laboratory and Geotechnical Services: Engage the services of an approved independent soils testing laboratory to perform the above-specified inspections and tests. Foundation and subgrade preparation and the placement and compaction of fills shall be performed under the surveillance of a (state) registered geotechnical engineer employed by the Contractor.
C. Tolerances:
1. Construct finished subgrades to plus 0 or minus 1/2 inch of the elevations indicated.
2. Construct finished grade of slopes not steeper than 3:1 plus or minus 1/2 inch and on slopes steeper than 3:1 plus or minus 2 inches. Do not encroach upon the trackway bed or roadbed.
3. Maintain the moisture content of fill material as it is being placed within plus or minus two percent of the optimum moisture content of the material as determined by the laboratory tests herein specified.

D. Blasting: Not allowed in the performance of the earthwork.

1.5 SUBMITTALS

A. In accordance with the applicable Division 1 Submittals section, submit the following:
1. A schedule of all tests specified to be performed by the Contractor.
2. Three (3) copies each of test reports of all tests specified to be performed.
3. Samples: Furnish and deliver samples of Common Fill, Selected Compacted Fill and Aggregate Backfill materials as selected by the Engineer for testing and analysis.
4. Permits for disposal of excavated material:
   a. Obtain written permits and releases from owners of property where material will be deposited.
   b. Submit copies of each permit and release from each property owner absolving the (owner) from responsibility in connection with such disposal.

B. Delivery Tickets: Submit a delivery ticket with each load of imported borrow material delivered to the site, stating the type of fill material and the quantity.

1.6 CLASSIFICATION OF EARTHWORK

A. No consideration will be given to the nature of materials encountered in excavating operations. Therefore, as unclassified excavation no additional payment will be made for difficulties occurring in excavating and handling of materials.

B. Where the required quantity of backfill exceeds the quantity of suitable site material, provide material at no increase to the Contract Price.

C. No right of property in materials is granted the contractor of excavated materials prior to backfilling. This provision does not relieve the contractor of his responsibility to remove and dispose of surplus excavated material of excavated material not suitable for backfilling.

1.7 JOB CONDITIONS

A. Unfavorable Weather Conditions:
1. Excavating, filling, backfilling, and grading work shall not be performed during weather conditions which might damage or be detrimental to the condition of existing ground, in-progress work, or completed work. When the work is interrupted by rain, excavating, filling, backfilling, and grading work shall not resume until the site and soil condition (moisture content) are suitable for compaction.
2. Subgrade shall be free from mud, snow, ice, and deleterious material when work is resumed.
3. Soil material which is too wet for compaction shall be left to drain, to be aerated and dried by diskimg and harrowing or other approved method until the moisture content of the area is uniform and within the specified limits.
B. Erosion Prevention: Protect stockpiles, ditches, embankments, filled, backfilled, and graded areas to prevent erosion until such time as permanent drainage and erosion control measures have been installed.

C. Barricade open excavations and post with warning lights those excavations occurring on property adjacent to or within public access. Operate warning lights during hours from dusk to dawn each day and as otherwise required.

D. Do not allow proof rolling equipment to enter area within seven feet of piers, abutments, and retaining walls retaining more than ten feet if equipment's gross weight exceeds 35 tons. Do not operate vibratory compactor having a gross weight more than 5,000 pounds closer than five feet to face of retaining wall. Do not operate non-vibrating equipment having an axle load of 21,000 pounds or greater closer than three feet from back of retaining wall. Grade to essentially finish grade on both sides of wall before starting to proof roll.

E. Do not operate proof rolling equipment having one axle loading of more than 21,000 pounds within height-of-fill-being-retained of retaining walls retaining less than ten feet.

F. Before moving equipment, including proof rolling equipment that exceeds 21,000 pounds for any axle, across underground duct banks having less than four feet of cover, place decking on the path of that equipment. Extend decking outward from each side of the duct bank for a distance equal to the depth of the bottom of the duct bank, but not further than four feet. Decking shall consist of a three inch thick timber platform or one inch thick steel plate. If duct bank is exposed, do not place decking directly on duct bank.

G. Use of Explosives: Is not permitted.

H. Toxic and Combustible Substances:
   1. During excavation, provide equipment and carry out such tests as necessary to detect presence of toxic and combustible substances.
   2. If the presence of noxious or explosive gas is indicated, immediately discontinue excavation operations and notify the Engineer. Do not resume work at this location until the necessary safety measures have been enforced and further tests indicate the absence of noxious and explosive gases.
   3. Take action to safeguard persons and property in accordance with rules and regulations of jurisdictional agencies and utility owners.
   4. Promptly notify utility owners when problems concerning their facilities become apparent.

I. The Contractor is cautioned that on-site materials do not meet the requirements for Selected Compacted Fill.

PART 2 PRODUCTS

2.1 FILL AND BACKFILL MATERIALS

A. General Requirements:
   1. Fill, backfill, and embankment material: Inert, non-expansive soil, free from organic matter and other deleterious substances and of such quality that it will compact thoroughly without the presence of voids when watered and rolled. Excavated on-site material will be considered suitable for fill, backfill, and embankment construction if it is free from organic matter and other deleterious substances and conforms to the requirements specified herein.
2. Excavated material which is suitable for fill, backfill, and embankment construction shall be conditioned for reuse and properly stockpiled for later filling and backfilling operations. Conditioning shall consist of spreading material in layers not to exceed 8 inches and raking free of debris and rubble. Oversize material and deleterious material shall be removed from the site and disposed of as specified herein under Disposal of Surplus Material.

3. Where conditions require the importing of fill or backfill material, the material shall be an inert, non-expansive soil or soil-rock material free of organic matter and meeting or exceeding the minimum requirements specified herein for the location.

B. Specific Requirements:
   1. Common Fill: Soil or soil-rock mixture free of topsoil, unsuitable material, vegetation, lumber, metal and refuse; and free of rock or similar hard objects larger than three inches in any dimension, with the exception that highly plastic clays and silts will not be permitted.
   2. Selected Compacted Fill: Soils meeting the requirements for Common Fill with a maximum particle size of 3 inches and classifying as GW, GM, GC, SW, SM, SC in accordance ASTM D 2487. Soils classifying as CL will be acceptable if the liquid limit, determined in accordance with ASTM D 4318, does not exceed 40.
   3. Aggregate Backfill: No. 2A Coarse Aggregate conforming to PENNDOT Section 703.2.
   4. Structural Foundation Backfill: Class C Concrete conforming to PENNDOT Section 704.1.

2.2 MATERIALS FOR EARTHWORK [C]
   A. Fill and Backfill Materials: Where specific fill, backfill, and embankment materials are not indicated on Contract Drawings, conform to the following requirements:
      1. Fill below Paved or Landscaped Areas: Common Fill.
      2. Fill below Slabs-on-grade and within 5 feet of Structures: Selected Compacted Fill. Provide a minimum of 6 inches of Aggregate Backfill directly below slabs-on-grade.
      3. Backfill against Concrete Walls and Waterproofing: Aggregate Backfill.
      5. Backfill for Abandoned Vaults (including airways, cross adits, and similar voids): Aggregate Backfill.
      6. Backfill Under Supporting Walls and Columns and Similar Locations: Aggregate Backfill or Structural Foundation Backfill, as directed by the Professional. [C]

2.3 SOURCE QUALITY CONTROL [C]
   A. Fill backfill, and embankment materials proposed to be used in the work shall be tested in the laboratory for compliance with specified requirements as follows:
       1. Moisture-Density Relationship: ASTM D 698, Method D.
   B. Where classification of soils is necessary to meet specified requirements, perform laboratory tests in accordance with ASTM D 2487.
   C. Aggregate Backfill shall meet the following requirements: [C]
      1. Use aggregate provided only from PENNDOT approved sources. [C]
      2. Use aggregate quarried from the following formations in the Central Pennsylvania region: [C]
         a. Limestone [C]
            1) Nealmont Formation (Rodman and Centre Hall members) [C]
2) Linden Hall Formation (Valentine, Valley View, and Stover members) [C]
3) Snyder Formation [C]
4) Hatter Formation [C]
b. Dolostone [C]
   1) Bellefonte Formation (Tea Creek and Coffee Run members) [C]
   2) Nittany Formation [C]
c. Mixed Limestone and Dolostone [C]
   1) Axemann Formation [C]

3. The selected aggregate material shall meet the following restrictions: [C]
   a. Contain less than 0.5% pyrite (i.e. 0.3% S) [C]
   b. Contain less than 1% deleterious materials [C]
   c. Limit the sulfur content to 0.1% if it is in the form of frambooidal pyrite in a carbonaceous shale or as whisker pyrite veins [C]
   d. Contain less than 15% thin, elongate, or platy pieces. [C]

4. Provide advance examination and testing according to methods referenced, or as directed, for aggregate materials. [C]
   a. Conduct aggregate quality tests in accordance with requirements of PENNDOT Section 703. [C]
   b. Conduct petrographic examination of aggregate samples representative of proposed material according to procedure defined in ASTM C 295. Examination shall be performed by an experienced petrographer. [C]
   c. Conduct chemical analysis of aggregate samples representative of proposed materials according to procedure defined in ASTM C 1580. [C]
   d. Professional reserves the right to accept aggregate materials based on certification from supplier that aggregate originates from a source approved by PENNDOT and that the aggregate complies with specified PENNDOT requirements and the additional requirements included herein. [C]

5. Contractor providing aggregate shall submit Independent Testing Agency test results indicating compliance with the above conditions prior to the start of work and every 3 months thereafter. In addition, Independent Testing Agency shall perform testing of aggregate samples any time the source of aggregate is changed. [C]

2.4 SOURCE OF MATERIALS

A. To the extent that it is available, obtain material from excavation operations. If sufficient suitable materials are not available to meet embankment, fill and backfill requirements, obtain material meeting specified requirements from outside sources at no additional cost to the Owner.
   1. Earth excavation may contain excess moisture in its natural state or may take on excess moisture during handling and stockpiling. Manipulation to dry material to proper moisture content prior to compaction may be necessary. Earth excavation will not be considered as unacceptable backfill material by virtue of its moisture content only.

B. Use only material whose quality, source, and zone of placement in the fill have been approved.

C. If borrow areas are provided by the Owner within the right-of-way, dress and shape such areas to ensure positive drainage when borrow operations are completed.
PART 3 EXECUTION

3.1 STAKING AND GRADES

A. Layout the work, establish all necessary markers, benchmarks, grading stakes, and other stakes as required.

B. Perform surveys in accordance with the requirements of the applicable Division 1 specification section. Surveys shall include:
   1. Initial survey of original ground.
   2. Final surveys when excavations, backfills, and embankments are completed.

3.2 EXISTING UTILITIES

A. Verify on site the location and depth (elevation) of all existing utilities and services before performing any excavation work. Perform excavation within 3 feet of a utility line by hand.

B. Remove abandoned sewers, piping, and other utilities encountered during excavation and plug the ends.

C. Report immediately to the Engineer any active utility lines encountered, which are not indicated in the Contract Documents, and notify utility owners involved. The Project Manager and utility authorities shall be permitted free access to determine the measures deemed necessary to repair, relocate, or remove the utility.

3.3 EARTHWORK GENERAL REQUIREMENTS

A. Erosion Protection: Prevent erosion of the site at all times. Construct temporary berms and dikes and cut temporary swales to promote natural drainage of site.

B. Construction Traffic: Disperse travel paths of traffic and construction equipment over entire width of compacted surfaces so as to aid in obtaining uniform compaction. Protect exposed soil layers with high moisture content from excessive wheel loads.

C. On-Site Excavation or Borrow Pits: Do not excavate or remove any material from the project site or right-of-way which is not within the designated excavation, as indicated by the slope and grade lines.

D. Salvaging Topsoil:
   1. Salvage topsoil within the neat lines indicated on the Contract Drawings, and stockpile on the site at a location determined by the Engineer. Prevent topsoil from contamination by other materials, and provide adequate drainage and erosion protection.
   2. Place stockpiled topsoil in areas designated on Contract Drawings.

E. Stockpiling of Fill and Backfill Material:
   1. Excavate and separately stockpile suitable fill and backfill material. Save sufficient suitable excavated material, if available, for later filling, backfilling, and embankment construction.
   2. Store materials from required excavations which are suitable for fill, backfill, and embankment as excavated, in stockpiles segregated by type.

F. Disposal of Surplus Material:
   1. Haul from the site and legally dispose of excess excavated materials and those materials determined to be not suitable for fill or backfill.
2. Location of disposal site and length of haul shall be the Contractor's responsibility.
3. Surplus material may be disposed of within the site as directed by the Engineer.

G. Maintenance of Excavations, Slopes, and Embankments:
1. Excavate and remove material outside the limits of excavation which is unstable and constitutes potential slides, and material which comes into excavations for any reason including from the driving of piles.
2. Maintain slopes and embankments until final completion and acceptance of the work. Promptly repair slides, slipouts, washouts, settlements, and subsidences which occur for any reason, and refinish the slope or embankment to the indicated lines and grades.

3.4 SUBSURFACE EXTRACTION

A. Remove subsurface facilities and obstructions to the extent indicated.

B. When subsurface facilities are encountered during excavation which interfere with new construction, and such facilities are not indicated, notify the Engineer promptly for corrective determination.

3.5 ROUGH GRADING AND FILLING

A. Prior to commencement of structural earthwork, perform such soil and rock removal and filling as may be required to facilitate the progress of the work and bring all elevations to the rough grading lines indicated on Contract Drawings. Grading shall be by blading or as herein specified under Article 3.6.

B. Fill or backfill wells, test pits, or holes which will not be completely removed by excavation, with Structural Foundation Backfill, Aggregate Backfill or Selected Compacted Fill, and compact as herein specified in layers not exceeding 6 inches after compaction.

C. Fill or backfill holes, swales, and low points which will not otherwise be removed in the course of the work, to the indicated grades.

3.6 DEWATER

A. Keep excavations free from water during the performance of the work. Provide and operate dewatering equipment of sufficient capacity for dewatering the excavations.
1. Provide for the disposal for the water removed from excavations in such manner as not to cause injury to the public health, to public or private property, to the work of others, to the portion of the work completed or in progress, nor to cause an impediment to the use of streets, roads, and highways.
2. Control groundwater and surface water during construction in order to maintain soil stability.
3. Maintain the water table elevation sufficiently below the levels of excavation so that slopes will remain stable and bottoms of excavations will not become loosened by flow of water.
4. If the foundations material looses its strength due to improper dewatering techniques, over-excavate the material and replace it with Structural Fill at no increase in Contract Price.
5. Dewatering efforts are to be maintained until excavations are closed or when determined by the Owner or Engineer no longer necessary.
6. Maintain site drainage throughout earthwork operations to minimize wet weather delays, reduce the accumulation of moisture from run off and precipitation, and reduce risk of sinkhole related subsidence.
3.7 EXCAVATION

A. General Excavation Requirements:
1. Perform excavating as indicated and required for concrete footings, foundations, exterior paving, floor slabs, concrete walks, and for site levels and grading, and provide shoring, bracing, underpinning, cribbing, pumping, and planking as required.
2. The bottoms of excavations shall be level, firm, undisturbed earth, clean and free from loose material, debris, and foreign matter.
3. Excavate to the lines and grades indicated on the Contract Drawings.
4. Support and maintain excavations so that sides are stable and will not move. Excavations may be maintained by sloping cut faces where space permits, or by providing structural support of earth walls.
   a. Where the sides of excavations are sloped, angle of slopes shall be as approved by the Engineer but shall not be steeper than allowed by the Title 29 Code of Federal Regulations, Part 1926, Safety and Health Regulations for Construction (OSHA).
   b. Maintain sides and slopes of excavations in safe condition until backfilling is completed.
   c. Where the Contractor elects to slope the sides of excavations, backfill of the over-excavated areas shall be made in the same manner specified for the adjacent excavated area. All additional backfill required shall be at no additional cost to the Owner.
5. Limits of excavations shall allow for adequate working space for installing forms, wall waterproofing, and as required for safety of personnel. Cut excavations in solid rock accurately to the neat lines indicated on Contract Drawings, or to the width of the duct bank or concrete encasement.
6. Remove unstable bottom material. Remove large stones, debris, and incompressible soils from common excavation bottoms to a minimum depth of 12 inches. Where required to excavate to rock, it shall be understood to mean sound bedrock. Remove friable and unsound material.
7. Except as otherwise indicated, preserve the material below and beyond the lines of excavations. Where excavation is carried below the indicated grade, backfill to the indicated grade as herein specified.
8. Excavation and its restoration, for convenience of the Contractor, shall be at no additional expense to the Owner.
9. Place excavated material at sufficient distance from edge of excavation so as not to cause cave-ins or bank slides, but in no case closer than 3 feet from the edge of excavations.
10. Unauthorized over excavations for footings and foundations shall be filled with approved materials to indicated elevations.
11. Condition excavated earth material which is suitable for fill, backfill, or embankment for re-use and properly stockpile for later filling and backfilling operations as herein specified. Test, screen, and mix as necessary to meet specified requirements.
12. Proceed with caution in areas of utility facilities; expose them by hand excavation or other methods acceptable to the facility owner.
13. If unsuitable materials are encountered at the required subgrades, the Engineer may authorize the removal of such unsuitable materials and replacement with suitable compacted fill or with concrete.

B. Rock Excavation:
1. Rock which cannot be broken up and removed by ripper equipment shall be excavated and removed by drilling.
2. If the depth of the cut is more than can be drilled from the top, an 18 inch offset will be allowed in the slope to begin succeeding drilling operations. The end result shall be a relatively smooth shear plane with localized irregularities which do not exceed 2 feet
behind or 1 foot in front of the shear plane surface and which do not extend within the
neat lines of the excavation.
3. Where footings or foundations are to be placed on rock which is not horizontal, key the
center of the foundation approximately 12 inches in depth throughout an area
approximately equal to the dimensions of the column or footing to be placed on the rock,
or the entire width of the slab, at not more than 10-foot intervals. Remove loose
fragments, and clean and fill all seams with lean concrete. Dowels may be considered if
the surface of the rock dips greater than 20 degrees from horizontal. Spacing, size and
depth of dowels will be as directed by the Engineer.
4. Material excavated beyond or below the indicated cross section shall be at the
Contractor's expense. Fill overbreakage to required invert with Structural Foundation
Backfill at no additional expense to the Owner.
5. Leave the side slopes of rock cuts with reasonably uniform faces whether the excavation
is carried beyond the specified side slopes or not. Conform sloped surfaces to the typical
section indicated or to natural cleavage planes, where these are compatible with the
typical section.
6. Solid rock boulders 24 inches in greatest dimension and boulders of lesser dimension,
broken rock, and all stones occurring within the construction limits and not required for
other construction, may be used for rock fill if suitable.

3.8 EMBANKMENT CONSTRUCTION

A. Place initial layer of embankment, fill, and backfill only on subgrade which has been inspected
and accepted by the Engineer.

B. Construct embankments to lines, grades, and contours indicated, in layers as nearly uniform
and horizontal as is consistent with the indicated finished contour and profile. Maximum
thickness of the layers shall conform to the following requirements:
   1. Fill, Selected Compacted Fill and Aggregate Backfill: 8 inches before compaction and 6
      inches after specified compaction.

C. Compact each layer to specified density for entire width of the fill or embankment. Achieve
required compaction by rolling with compaction equipment suitable for type and condition of the
particular material. Roll in a longitudinal direction parallel to longest dimension, starting at outer
edges and progressing toward the center.

D. Moisture-condition embankment, fill and backfill material as required to achieve its compaction
to the specified density, within the tolerances specified herein.

E. Do not compact material which contains excessive moisture. In such cases, scarify to the full
depth of the layer having excessive moisture content and dry by reworking, mixing with dry
materials, or other approved methods.

F. Remove material which cannot be compacted to required density within specified tolerances,
and replace with suitable material at no additional expense to the Owner.

G. Where pipes, culverts, or structures extend into embankments, construct embankment to at
least 2 feet over and 10 feet on either side of the pipe, culvert, or structure location prior to
excavation.

H. Do not commence final shaping until above specified requirements have been completed.
Shape entire surface of trackway and the slopes of cuts and embankments to true grade,
alignment, and cross section indicated. Leave cut slopes in rock with uniform surface, and
remove all loose overhanging rock. Open ditches, drains, and culverts resulting from
construction operations to drain effectively.
I. Where utility facilities and structures are supported in place, use special equipment and techniques as required to achieve specified compaction under and around them.

J. When backfilling against structures, place material approximately simultaneously on both sides of structures to equalize opposing horizontal pressures.
1. Compact embankment, fill, or backfill materials within five feet of retaining walls, abutments or other structures using lightweight compactors.
2. Backfilling against new structures without approval is prohibited.

K. When backfilling on tops of structures, place material in six inch lifts over full area.

L. Prior to placing embankment against slopes greater than one vertical to four horizontal cut benches into existing slopes. Height of bench not to exceed two feet unless otherwise approved.

M. Protection of Existing Facilities:
1. During excavation, monitor existing structural elements for settlement in a manner approved by the Engineer, recording elevations to 0.001 foot.
2. Monitor existing structures within a distance of three times the depth of excavation for footings and mats.
3. Obtain the Engineer's approval of the number and location of monitoring points. Take elevations before beginning construction, daily during excavation and backfill, weekly for two weeks after completing backfill, or as directed by the Engineer.

3.9 SUBGRADE PREPARATION

A. Perform all cutting, blading, and shaping as required to cut and shape the subgrade to the grades and elevations indicated.

B. Subgrade preparation includes proof rolling, fine grading, reworking as necessary, and preparation of cut, fill, or embankment upon which structure and equipment foundations, pipe, subballast, subbase, base, and pavement will be placed.

C. Remove rigid pavements, slabs, and foundations which would be within five feet of finished grade and subgrade. Rigid pavements and slabs which will be five feet and more below finished grade and subgrade may be left in place only if broken into pieces not larger than three feet in greatest dimension.

D. Subgrade Proof Rolling of Building Pad Locations: Notify the Engineer two days prior to proof rolling operations.
1. Perform proof rolling following removal of topsoil, after excavation to subgrade (or acceptable limits) in cut areas, and before any fill material is placed or other construction performed. Perform proof rolling as shortly as possible before fill materials are placed on subgrade, in order to maximize the chances of disclosing any weak areas that developed during the time the subgrade was exposed to rainfall.
2. Perform proof rolling with a large piece of rubber-tired equipment, such as a loaded tandem-axel dump-truck or pan excavator having a weight of at least 70,000 pounds. Equipment tires to make a minimum of two complete passes over the area being proof rolled, one pass in each direction, traveling at a speed of 2 to 3 miles per hour (about the pace of a slow walk).
3. Proof rolling to be observed by an experienced Engineer who can evaluate the suitability of the subgrade soils, and delineate the area and depth of any unsuitable materials encountered.
4. Problem areas may exhibit excessive settlement, or outright collapse in the case of voids extending close enough to subgrade. If loose, soft or otherwise unstable areas are found, they shall be excavated to firm material and backfilled with suitable material.

5. Perform proof rolling only when weather conditions permit. Do not proof roll wet or saturated subgrades. When materials are degraded by proof rolling a wet or saturated subgrade, replace such materials as directed by the Engineer at no additional expense.

D. Scarify and mix entire surface of subgrade to a depth of at least 6 inches.

E. After the material has been loosened, accurately construct and fine grade the subgrade to indicated line, grade, and contour with high and low spots eliminated. Compact for full width to the specified density. Remove soft spots developed during working, fill with approved material, and re-compact.

F. Finish subgrade to straightedge or template within specified tolerances with the finished surface bladed to a uniform, dense, smooth texture.

3.10 FOUNDATION PREPARATION

A. Complete construction of the excavation support and dewatering systems prior to placement of structure and equipment foundations.

B. Avoid disturbing bottom of excavation. If bottom is disturbed, restore and stabilize the bearing foundation at no additional expense to the Owner.

C. Foundations shall bear on sound rock. If top of rock is below foundation elevation, excavate to top of rock and backfill to foundation elevation with Structural Foundation Backfill (Class C Concrete).

D. Excavate and clean soil seams or depressions where encountered in the rock surface to a minimum depth equal to the width of the soil filled fracture at the top of the rock surface. At the direction of the Engineer, fill excavated seams or depressions with Structural Foundation Backfill (Class C Concrete).

3.11 SUBGRADE FILLING/RAISING GRADE

A. Construct compacted fill for raising of subgrade to indicated elevation by approved and accepted methods. Spread fill material in uniform lifts not exceeding 8 inches in uncompacted thickness. Fill material which does not contain sufficient moisture to compact properly shall be sprinkled with water; if it contains excess moisture it shall be aerated or permitted to dry to the proper water content. Fill material and water shall then be thoroughly mixed before being compacted. Compact each layer of spread fill material to the specified density.

B. Control of fill shall consist of field inspection and testing to determine that each layer has been compacted to the required density and to ensure that optimum moisture is being obtained. Any layer or portion of a layer that does not attain the compaction required shall be scarified and recompacted until the required compaction is obtained.

C. Perform spreading and compacting as required to produce the required density and a uniform surface smooth and true to grade.
3.12 COMPACTION

A. Compaction Density: Compact each layer of embankment, fill, and backfill material to not less than the indicated or specified compaction. Required compactions are defined as Class I or Class II, as follows:

Class I Compaction: 97 percent of the maximum dry density, with a moisture content within two percentage points of optimum moisture content, as determined by ASTM D 698 D. If the material is too coarse to satisfactorily use this method, compaction will be determined by the Engineer based on non-movement of the material under compaction equipment. Vibratory compaction of coarse material will be required.

Class II Compaction: 100 percent of the maximum dry density, with a moisture content within two percentage points of optimum moisture content, as determined by ASTM D 698 D. If the material is too coarse to satisfactorily use this method, compaction will be determined by the Engineer based on non-movement of the material under compaction equipment. Vibratory compaction of coarse material will be required.

B. Required Compactions:
1. Common Fill where surface will be landscaped area: Class I for full depth.
2. Common Fill where surface will be paved area: Class I under top 12 inches; Class II for top 12 inches.
3. Selected Compacted Fill: Class II for full depth.
4. Aggregate Backfill: Class II for full depth.
5. Cut and Cover Backfill: Class I to 36 inches above structure or utility; Class II for balance.
6. Original Ground or Cut Subgrade:
   a. Under paved or landscaped areas, provide Class I compaction for at least 12 inches in depth.
   b. Below slabs-on-grade and within 5 feet of structures, provide Class II compaction for at least 12 inches in depth.

3.13 BACKFILLING

A. Use materials removed from site excavations if such material meets specified requirements.

B. Backfilling is required around all substructures. Fill all abandoned vaults, shafts, airways, adits, holes, pits, and other voids.

C. Place backfill in layers not to exceed 8 inches of loose material, and compact each layer to specified density before the next layer is placed.

D. Place backfill material in such manner that unbalanced horizontal loads will not be applied to a newly-placed structure or portion of structure, utilities, or pipelines. Do not backfill around portions of structures requiring backfill on only one side or on less than all sides, until the concrete has reached the specified strength to withstand the earth pressures.

E. When placing material for backfill around waterproofed structures, protect such structures and the waterproofing thereof with a shield when necessary to prevent displacement or injury by stones or other hard substances in the backfill.

F. Do not backfill on or against structural concrete until the specified 28-day concrete strength has been attained.
G. Complete backfill for end bents and abutments, including backfill for wingwalls, in accordance with the above specified time limit. Step slopes behind abutments, unless otherwise indicated, to prevent backfill from acting as a wedge against the abutment. Provide drainage behind abutments and wingwalls as indicated.

H. Do not use compaction equipment and methods that produce excessive horizontal or vertical earth pressures.

3.14 FINISH GRADING

A. Finish grade all areas to elevations and grades indicated. In areas to receive topsoil and landscape planting, finish grading shall be performed to a uniform 6 inches below the grades and elevations indicated.

B. Place and spread stockpiled topsoil to a uniform thickness of 4 to 5 inches (approximately) in areas to receive topsoil and landscape planting. Place and spread to a uniform thickness approximately 1 to 2 inches below finish grades indicated.

3.15 FIELD QUALITY CONTROL

A. Inspections and Tests by the Contractor:
   1. Density Tests: Compacted fill, backfill, and embankment shall be tested to verify compliance with specified requirements in accordance with ASTM D 2922. Minimum frequency of tests shall conform to the following requirements:
      a. Expansive Horizontal Areas: One test per 100 cubic yards, or fraction thereof, of fill or backfill placed.
      b. Confined Areas, Trenches, and Embankments: One test per lift of fill, backfill, or embankment placed.
   2. Tests for compaction shall be made in accordance with test procedures outlined in ASTM D 698, Method D, as applicable. Field testing of soils or compacted fill in place shall be performed in accordance with applicable requirements of ASTM D 2922.
   3. Moisture Content Tests: Compacted fill, backfill, and embankment shall be tested to verify compliance with specified requirements in accordance with ASTM D 3017. Minimum frequency of tests shall be as specified above for density tests.

B. Inspections by the Engineer:
   1. Site preparation, cutting and shaping, excavating, filling, backfilling, and embankment construction shall be carried out under the inspection of the Engineer, who will have the Contractor perform appropriate field and laboratory tests, as necessary, to evaluate the suitability of fill and backfill material, the proper moisture content for compaction, and the degree of compaction achieved. Fill or backfill that does not meet the specified requirements shall be removed or recompacted until the requirements are satisfied.
   2. Cutting and shaping, excavating, conditioning, filling, backfilling, and compacting procedures require approval of the Engineer as they are successively performed. Work found to be unsatisfactory or work disturbed by subsequent operations before approval is granted shall be corrected in an approved manner as directed by the Engineer.

END OF SECTION 31 20 00
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Excavation, backfill, and embankment necessary to grade site to lines indicated on Drawings.

B. Related Sections:
   1. Submittal Procedures: Applicable Division 1 specification section.
   2. Section 31 41 00: Shoring.
   3. Section 31 20 00: Earth Moving.
   5. Section 31 25 00: Erosion and Sedimentation Control.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. AASHTO T 99, Moisture-Density Relations of Soils, Using a 5.5 lb. Rammer and a 12 inch Drop.

B. American Society for Testing and Materials (ASTM):
   2. ASTM D 1140; Test Method for Amount of Material in Soils Finer than the No. 200 (75 Micrometer) Sieve.
   3. ASTM D 1556, Density of Soil in Place by the Sand Cone Method.
   4. ASTM D 1557; Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft.\(^3\) (2,700 kN-mm/m\(^3\))).
   5. ASTM D 2167, Density of Soil in Place by the Rubber-Balloon Method.
   7. ASTM D 2487; Classification of Soils for Engineering Purposes (United Soil Classification System).
   8. ASTM D 2922; Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   9. ASTM D 3017; Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
  10. ASTM D 4253; Test Methods for Maximum Index Density of Soils Using a Vibratory Table.
  11. ASTM D 4254; Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

C. Occupational Safety and Health Administration (OSHA).

1.3 DEFINITIONS

A. Rock Excavation: Consolidated hard mineral material mass exceeding 1/2 cubic yard in volume that, in Engineer's opinion, cannot be excavated except by drilling and blasting or drilling and wedging. Structure foundations of concrete or of masonry or stone laid in cement mortar is also classified as rock if volume requiring removal at a single location exceeds 1/2 cubic yard.
B. Earth Excavation: Materials in excavation that, in opinion of Engineer, cannot be classified as rock excavation.

C. Unclassified Excavation: Material removal of any kind in excavation, including Rock Excavation.

D. Subgrade: Prepared earth surfaces where on or over additional materials are placed or work is performed.

1.4 SUBMITTALS

A. Test Reports: Submit for approval complete sieve analysis, compaction density, liquid limit, and plastic limit test reports for on site and borrow excavated material desired to be used for backfill and embankment fill. Test in accordance with specified Reference Standards. For disapproved material, either submit for approval above data for new borrow material, or procedures and materials proposed to be used to obtain approved stabilizations and densities for excavated materials.

B. Testing Agency: Submit name and qualifications of Testing Agency performing tests to Engineer for approval prior to proceeding with operations.

1.5 PROJECT CONDITIONS

A. Classification of Excavated Materials: No consideration will be given to nature of materials encountered in site grading operations. Therefore, as unclassified excavation, no additional payment will be made for difficulties occurring in excavating and handling of materials.

B. Environmental Requirements:
   1. Do not perform grading when soil or weather conditions are unsuitable. Unsuitable conditions include moisture saturated or frozen in place soil and precipitation present on soil or occurring during Work.
   2. Exercise necessary means and methods to control dust on site as well as in off site work areas where excavation and grading are required.
   3. Do not leave site in a dusting condition following work of this Section. If necessary, employ a watering schedule to control dust.
   4. Do not use frozen material in performing work or place materials on frozen surfaces.
   5. When it is necessary to haul soft or wet soil material over roadways, use suitably tight vehicles to prevent spillage. Clear away spillage of materials on roadways caused by hauling at no expense to Owner.
   6. Plan work so as to provide adequate protection during storms with provisions available constantly for preventing flood damage.
   7. Slope trench excavations and embankments to prevent puddling. Control runoff in accordance with Section 31 25 00: Erosion and Sedimentation Control.

C. Explosives and Blasting: Not permitted in performance of site grading work.

D. Protection: Assume risks attending presence or proximity of overhead or underground public utility and private lines, pipes, conduits and support work, existing structures and property of whatever nature, in or over excavations or adjacent to excavations. Assume complete responsibility for replacement and restitution work of whatever nature to above, as damaged or destroyed by work of this Contract, and at no expense to Owner.
   1. Outside Property Limits or Rights-of-Way: Take necessary precautions to protect trees, shrubs, lawns and other landscaping from damage. Restitution work for damages rests solely with Contractor and at no expense to Owner.
2. Temporary Protective Construction: Erect and maintain without expense to Owner, substantial barricades to exclude pedestrians or vehicles.

E. Borrow Excavation: Where required quantity of backfill exceeds quantity of suitable material excavated within limits of project site and Rights-of-Way, obtain sufficient material to complete backfill at no additional cost to Owner. If borrow excavation is needed, notify Engineer sufficiently in advance of borrow excavation requirements to permit Engineer to verify need for borrow excavation and to view proposed borrow pit. Borrow excavation from outside sources is subject to approval of Engineer. Obtain written consent before use of borrow excavation from outside sources.

F. Excess Materials: No right of property in materials is granted of excess on site materials prior to completion of Site Work. This provision does not relieve responsibility to remove and dispose of surplus excavated materials. Dispose of legally off site, unsuitable materials including sod, stumps, spongy soil, as well as excess rock.

G. Accommodation of Traffic: Do not obstruct streets, roads, and highways. Unless Municipality, Governing Agency, or Engineer authorizes in writing complete closing of street, road, or highway, employ necessary measures at no expense to Owner to keep street, road, or highway open and safe for traffic.

H. Excavation Limits: Excavate to lines, grades and slopes indicated on Drawings or to depths and dimensions required to produce a satisfactory foundation surface as determined by Engineer.

I. Slopes of Opencut Excavation: Maintain stable slopes, and comply with OSHA requirements for slopes of opencut excavation. Overexcavation without authorization by Engineer will not be paid for, nor will payment be made for overexcavation and refill. Remove slides of material and repair at no additional cost.

1. Excavate slopes to angles necessary to ensure safe working conditions and stable slopes.

J. Scaling: Scaling of excavated rock and earthen surfaces is required throughout life of Contract. Scaling produces surfaces free from loose and dangerous rock. Utilize protective fencing at toes of slopes, mesh coverings on slopes, or other devices where recurring problems exist or where scaling alone is not sufficient.

K. Temporary sheeting, shoring and bracing as specified in Section 31 41 00: Shoring.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Embankment and Backfill in Areas 5 Feet Beyond Structures (General Fill): Use on site or borrow excavated soil or soil rock material free of topsoil, plant life, lumber, metal, and refuse and meeting following requirements for site grading backfill and embankment 5 feet beyond structures. Rocks contained in suitable material must pass through a 6 inch by 3 inch opening, and not exceed 10 percent of backfill or embankment volume. Provide soil with at least 60 percent passing #4 sieve when tested in accordance with ASTM D 422; a liquid limit of not more than 45 and a plasticity index of not more than 25 when tested in accordance with ASTM D 4318; and a maximum dry density of not less than 100 pounds per cubic foot.
B. Backfill and Embankment in Areas Below or within 5 feet of Structures (Select Compacted Fill):
On site or borrow excavated soil meeting above requirements for General Fill and embankment areas 5 feet beyond structures, except size of rock not to exceed 3 inches in largest dimension.

PART 3 - EXECUTION

3.1 PREPARATION

A. Salvaged Topsoil: Within areas indicated for grading, strip topsoil to depth of suitable topsoil material and stock pile for subsequent topsoiling operations. See Section 31 20 00: Earth Moving.


3.2 PERFORMANCE

A. Erosion Control: Implement erosion control measures prior to and during performance of work of this Section. Erosion Control as specified in Section 31 25 00: Erosion and Sedimentation Control.

B. Excavation of Borrow Material: Perform excavation of borrow material in a manner satisfactory to Engineer. Strip borrow pits of brush, trees, roots, grass and other vegetation prior to removal of material for use in backfill. During excavation operation, grade borrow area to ensure free drainage of water from area. Place and maintain erosion control devices after completion of excavation, grade excavated area including side slopes to drain and present a uniformly trim appearance merging into surrounding terrain. After borrowing operations are completed, regrade area, if necessary, to prevent erosion.

C. Removing Obstructions: Where rock is encountered at proposed subgrade elevations and topsoil is required, remove rock for a depth of twelve inches below proposed subgrade.

D. Preparation of Subgrade for Embankments: Perform sufficient in place density tests on supporting material to show that material is in stable condition with proper density. Compact supporting material if necessary.

E. Placement and Compaction of General Fill: Construct embankments, except embankments for roadways and around new structures, in accordance with following paragraphs.

1. Place fill in lifts no thicker than one foot and compact using approved equipment. Carry whole embankment up evenly to required elevation without breaks or irregularities in material distribution or in formation of layers. Trim embankment slopes to lines indicated on Drawings and leave in a neat and acceptable condition.

2. Add water to fill not containing sufficient moisture to obtain required compaction. Harrow, or use other approved methods, to work moisture into material until a uniform distribution of moisture is obtained. Fill containing moisture in excess of moisture required to obtain necessary compaction density may not, without written approval, be incorporated in embankment until allowed to dry to a moisture content not greater than two percentage points above optimum for that particular material. Do not place frozen material, ice, or snow in embankments.

3. Fill existing natural or other depressions resulting from site work to level of adjacent ground elevation in manner specified for formation of embankment prior to starting initial embankment layer. Provide material for this operation of type used adjacent to structures.
4. Remove existing embankment foundation material when determined unsatisfactory by Engineer. Backfill areas to original elevation with general fill, placed and compacted as specified herein.

5. Scarify embankment foundation surface where embankment of three feet or more in height is placed. If compacted surface of any layer of material is determined to be too smooth to bond properly with succeeding layer, loosen surface by harrowing or by other method approved by Engineer before placing succeeding layer.

6. Plow existing embankment foundations having a slope steeper than four to one to provide embankment binding when required by Engineer. On steeper slopes Engineer may require foundation be cut into steps or berms.

7. Compact each lift with at least 5 passes of compaction equipment suitable for material being placed and suitable for requirements of fill. Suitability of equipment for fills to be determined by Engineer based on field performance of equipment. Furnish alternate compaction equipment if Engineer deems equipment being utilized is ineffective or inappropriate for conditions and requirements of fill being placed.

8. During dumping and spreading process, maintain a constant force of workers, adequate to remove and dispose of stones with dimensions greater than 3 inches by 6 inches, roots, and debris from embankment materials.

9. During construction, keep top of partially completed embankments shaped and drained continuously.

F. Placement and Compaction of Select Compacted Fill: As specified in Section 31 20 00: Earth Moving.

G. Topsoil: As specified in Section 31 22 19: Finish Grading.

3.3 FIELD QUALITY CONTROL

A. Field Moisture-Density Tests: When deemed necessary by Engineer, conduct a minimum of two field moisture-density determinations per 500 square feet placed in a horizontal layer at locations designated by Engineer. Field dry density to equal or exceed 95 percent of maximum dry density, and in place moisture content to be within percentage points of optimum moisture contents, as determined per ASTM D 1557.

1. Moisture content at which maximum density of backfill is obtained with a given compactive effort, AASHTO T 99, is considered optimum moisture content.

2. Field compaction density may be determined by Sand Cone Method ASTM D 1556, Rubber Balloon Method ASTM D 2167, Nuclear Method ASTM D 2922, or other acceptable method as approved by Engineer.

END OF SECTION 31 22 00
SECTION 31 22 19 - FINISH GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Placement and supplemental additions to topsoil as required to restore disturbed areas.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM C 602, Agricultural Liming Materials.

1.3 SUBMITTALS

A. Test Reports: Submit laboratory test reports of soil analysis and supplement recommendations to Engineer for approval prior to adding any soil supplements to topsoil.
   1. Laboratory reports to recommend both grade and application rates of fertilizer, and such other soil supplements as required.
   2. Take sufficient quantity of topsoil samples to give a representative analysis of on-site topsoil and topsoil from outside sources, if any.

B. Soil Supplement Product Certification: Submit certificates certifying such products to have a guaranteed analysis in conformity with Engineer approved laboratory soil supplement recommendations report.

1.4 QUALITY ASSURANCE

A. Quality Control:
   1. Packaged Products to indicate manufacturer’s guaranteed analysis on each package and arrive on site as originally packaged and unopened.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver packaged products to site in unopened containers with labels intact and legible.

B. Store packaged products in a manner to prevent moisture damage and other forms of contamination.

1.6 PROJECT CONDITIONS

A. Environmental Requirements: Do not perform work of this Section when soil or weather conditions are unsuitable. Unsuitable conditions include moisture saturated or frozen in place soil and precipitation of any kind present or occurring during work.

B. Existing Conditions: Following performance of related construction and prior to Finish Grading, perform debris removal and site leveling as necessary in preparation for Finish Grading. Dispose of debris legally off site.

C. Dust Control: Exercise necessary means and methods to control dust on site as well as in off site work areas where Topsoiling and Finish Grading are required.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil: Use fertile, friable, natural, productive surface soil as is available on site, if any. Use topsoil free of subsoil, clay, stones, or similar hard objects larger than 1 inch in greatest dimension and partially disintegrated debris and materials toxic or harmful to growth. Acceptable topsoil to contain organic matter in range of 1.5 percent to 20 percent.

B. Borrow Topsoil: Use productive topsoils from Contractor's source and of a quality meeting requirements specified above for Topsoil. Furnish any additional topsoil necessary to complete work at no additional expense to Owner.

2.2 SOIL SUPPLEMENT MATERIALS

A. Agricultural Liming Materials: Products containing calcium and magnesium compounds capable of neutralizing soil acidity and containing not less than 80 percent of total carbonates. Use liming materials meeting requirements of ASTM C 602 and conforming to applicable state liming material regulations.

B. Fertilizer: Commercial fertilizer of uniform composition, free-flowing and in conformity with applicable state fertilizer laws.

1. Analysis: As recommended by laboratory soil supplement recommendations report.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare subsoil surface for finish grading by dressing and shaping to provide for uniform placement of topsoil.

B. Prepare subsoil surface for topsoiling by loosening to a depth of 4 inches and dressing and shaping to provide for uniform placement of topsoil.

C. Remove surface rock or other foreign objects exceeding 3 inches in greatest dimension. Dispose of rock and debris off site in a lawful manner.

3.2 PERFORMANCE

A. Placement: Place topsoil over areas indicated for new grading contours. Ensure construction work in topsoiled areas is completed before topsoil placement. Observe precautions as follows:

1. Do not place topsoil over areas indicated to receive paving or walkways.

2. Do not work topsoil while frozen or wet. Do not work topsoil into a dusting condition. Moisten topsoil to prevent a dust nuisance.

3. Scarify subsoil to a depth of 4 inches for bonding topsoil with subsoil.

4. On sloped areas, work topsoil into subsoil to blend so as to eliminate any semblance of slip-planing between two soils; but leave a sufficient cover of topsoil to ensure seed germination. Perform blending of soils by ridging or serrating subsoil on slopes.

5. Place topsoil as needed for dressing-up minor depressions due to settling and erosion and to eliminate any other minor irregularities.
B. Finished Elevations and Lines: Grade topsoiled areas of site to within a tolerance of plus or minus 1/10 of a foot of elevations and lines indicated and in accordance with following:

1. Grade a uniform longitudinal fall in swales and other surface drainage areas to provide a drainage flow line that can easily be maintained and traversed with normal lawn maintenance equipment.
2. Establish finish grade of topsoil 1/2 to 3/4 inch below top of abutting walks or paving to provide positive drainage.
3. Do not finish grade topsoil to a depth less than 6 inches or greater than 12 inches.
4. Leave finish grade surfaces free of objectionable material larger than one inch in greatest dimension. Dispose of objectionable material in a legal disposal area off site.

C. Compaction: Compact finish grades as final operation using a light roller weighing not over 120 pounds per foot width of roller.

D. Tillage: Till finish graded soil over areas indicated for lawn regardless of type of lawn work performed. Use equipment and methods common to such work, and till soil to a 2-inch depth minimum.

E. Soil Supplement Addition: Soil supplements for lawn areas, as required according to Engineer approved laboratory test reports, may be incorporated into soil during tillage operations.

END OF SECTION 31 22 19
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Excavating, placing bedding, backfilling, and compacting trenches for pipelines and utility structures specified or indicated on Drawings.

B. Related Sections:
1. Section 31 41 00: Shoring.
2. Section 02 41 00: Demolition.
3. Section 33 01 01: Maintenance and Support of Existing Utilities.
4. Section 31 25 00: Erosion and Sedimentation Control.
5. Section 31 10 00: Paving and Surfacing.
7. Section 33 49 00: Storm Drainage Structures.
8. Section 03 30 53: Miscellaneous Cast-In-Place Concrete.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. ASTM D 698, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft.-lb/ft.3).
2. ASTM D 1556; Test Method for Density of Soil in Place by the Sand Cone Method.
4. ASTM D 2922, Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

B. Commonwealth of Pennsylvania Department of Transportation (PENNDOT), Specifications Publication 408, as supplemented.
1. PENNDOT Section 703.1, Fine Aggregate.
2. PENNDOT Section 703.2, Coarse Aggregates.
3. PENNDOT Section 703.3, Select Granular Material (2RC).

1.3 DEFINITIONS

A. Earth Excavation: Removal down to subgrade elevation of clay, silt, loam, sand, gravel, slate, hard pan, pavements, soft sandstone, loose stone in masses, and boulders measuring less than 1/2 cubic yard.
1. Earth Excavation is Unclassified.

B. Rock Excavation: Removal down to subgrade elevation of large rock and boulders measuring more than 1/2 cubic yard or drilling and wedging in opinion of Engineer.
1. Rock excavation is unclassified.


D. Subgrade: Trench bottom prepared as specified to receive Bedding, Concrete Cradle, or Concrete Encasement, or excavation bottom prepared to receive pipeline structures.
1.4 SUBMITTALS

A. Test Reports:
   1. Submit testing laboratory aggregate test reports based on requirements stated in Quality Control.
   2. Compaction density test reports based on method of density determination as specified in Reference Standards and method approved by Engineer.

B. Certificates: Submit certificate from aggregate supplier based on requirements stated in Quality Control, when requested by Engineer.

C. Product Data: Submit catalog cuts and such other data required to provide information for the following:
   1. Geotextiles.
   2. Warning Tape.

D. Calibration of Equipment: Submit a list of equipment; calibration procedure and frequency calibrated.

1.5 QUALITY ASSURANCE

A. Quality Control:
   1. Laboratory Tests: In accordance with the applicable Division 1 specification section for Quality Requirements, aggregate materials under Part 2 - Products require advance examination or testing according to methods referenced, or as required by Engineer.
      a. Arrange for testing laboratory to furnish Engineer test result reports in triplicate. Test reports are considered sufficient evidence of acceptance or rejection of materials represented.
      b. Conduct aggregate quality tests in accordance with requirements of appropriate Referenced Standard.
      c. Engineer reserves right to accept aggregate materials based on certification from supplier that aggregate originates from a source approved by PENNDOT and that aggregate complies with specified PENNDOT requirements.

1.6 PROJECT CONDITIONS AND EXECUTION

A. General Requirements: Excavate and backfill trenches necessary for completing work of this Contract. Excavate and backfill trenches by machinery or by hand; The Engineer is empowered, if necessary in his opinion, to direct that hand excavation and backfilling be employed. Excavate whatever substances encountered, to grades and depths indicated on Drawings, as specified, or as directed by Engineer. Remove and waste excavated material not required for backfill.

B. Environmental Requirements:
   1. Do not perform trenching, backfilling, or compacting when weather conditions or condition of materials will prevent satisfactory work, in opinion of Engineer.
   2. Do not use frozen materials as backfill or wet materials containing moisture in excess of quantity necessary for satisfactory compaction.
   3. Prior to use, moisten dry backfill material not having sufficient moisture to obtain satisfactory placement or compaction.
   4. Plan work to provide adequate protection during storms with provisions available constantly for preventing flood damage. Protect installed piping and other work against damage from uplift due to high ground water levels.
   5. Accommodation of Drainage: Keep gutters, sewers, drains, and ditches open constantly for surface drainage. No damming, ponding, water in gutters, or other waterways
permitted, except where stream crossings are necessary and then only to extent Engineer considers necessary. Do not direct water flows across or over pavements except through approved pipes or properly constructed troughs. When required, provide pipes or troughs of sizes and lengths required at no expense to Owner. Perform grading in vicinity of trenches so that ground surface is properly pitched to prevent water running into trenches.

6. Pumping: Keep excavations free from water during performance of work at no expense to Owner. Build dams and other devices necessary for this purpose, and provide and operate pumps of sufficient capacity for dewatering excavations. Provide for disposal of water removed from excavations in a manner not to cause injury to public health, public or private property, work of others, portions of work completed or in progress, or produce an impediment to street, road and highway usage.

7. When necessary to haul soft or wet soil material over roadways, use suitably tight vehicles to prevent spillage. Clear away spillage of materials on roadways caused by hauling.

8. Provide effective dust control by sprinkling water, use of calcium chloride or other method approved by Engineer. Employ dust control when, where and in a manner required by Engineer.

C. Explosives and Blasting: Not permitted in performance of trenching work.

D. Hydraulic hoe-ram equipment may be used with written approval of The Pennsylvania State University. Hoe-ram use may be limited as to time of day and size of unit.

E. Responsibility for Condition of Excavation: Assume responsibility for condition and results of excavation. Remove slides and cave-ins at whatever time and under whatever circumstance they occur.

F. Protection: Assume risks attending presence or proximity of overhead or underground public utility and private lines, pipes, conduits and support work, existing structures and property of whatever nature. Assume responsibility for damages and expenses for direct or indirect injury to structures or to person or property by reason of them or by reason of injury to them; whether structures are or are not shown on Drawings, by work of this Contract.

1. Outside Project Limits: Take necessary precautions to protect trees, shrubs, lawns and other landscaping from damage. Restitution work for damages rests solely with Contractor and at no expense to Owner.

2. Pipe Supports: Adequately support underground pipes or conduits exposed as a result of excavations. Provide adequate support along entire exposed length by timber or planking. Install supports in a manner that backfilling may be performed without dislodging pipes or conduits. Place and carefully compact Coarse Aggregate around supports, and leave supports in place as a guard against breakage due to backfill settlement. No additional payment will be made for support material left in place or for labor of installing and maintaining supports.

G. Structure Supports: Where trenching past buildings or structures that by their construction or position might exert detrimental pressure upon trench, right is reserved by Engineer to require that buildings or structures, be underpinned or supported and protected, or special sheeting be driven, or that short lengths of trench be opened at one time.

H. Removal of Obstructions:

1. Remove, realign, or change direction of above or below ground utilities and appurtenant supports, if required in opinion of Engineer. Perform as extra work unless performed by owner of obstruction without cost to Contractor. However, uncover and sustain obstruction at no additional cost prior to final disposition of obstruction. No claims for damage or extra compensation due to presence of obstructions or delay in removal or
rearrangement of obstructions will be made. Additional precautions concerning obstructions as follows:

a. Do not interfere with persons, firms, corporations, or utilities employing protective measures, removing, changing, or replacing their property or structures, but allow taking measures necessary or advisable under circumstances, without relieving responsibilities of Contract.
b. Without extra compensation, break through and reconstruct if necessary, invert or arch of sewers, culverts or conduits encountered if structure is in a position, in judgment of Engineer, as not to require its removal, realignment or complete reconstruction.

I. Advance Trenching: Where existing utilities or other suspected underground obstructions are within close proximity of proposed pipelines, uncover and verify exact location of obstructions far enough in advance of pipelaying to allow changes in pipe alignment or grade required to bypass obstructions and to avoid removing sections of pipe already installed. If sections of installed pipe require removal and reinstallation as a result of not verifying utilities or other underground obstructions far enough in advance, remove and reinstall pipe at no additional cost.

J. Excess Materials: No right of property in materials is granted for excavated materials prior to backfilling. This provision does not relieve responsibility to remove and dispose of surplus excavated materials. Obtain written consent and any necessary permits and approvals before disposing of excess materials at an off-site location.

K. Borrow Excavation: Where required quantity of backfill exceeds quantity of suitable material excavated within limits of Project site, obtain sufficient material to complete backfill at no additional cost to Owner. If borrow excavation is needed, notify Engineer sufficiently in advance of borrow excavation requirements to permit Engineer to verify need for borrow excavation and to view proposed borrow pit and determine suitability of material to be provided. Borrow excavation from outside sources is subject to approval of Engineer. Obtain written consent and any necessary permits and approvals before use of borrow excavation from outside sources.

L. Change of Trench Location or Depth:
1. Should Engineer require a change in location of a trench from that indicated on Drawings due to presence of an obstruction, or from other cause, and change in location is made before excavation is begun, no extra compensation or claim for damages will be granted.
2. If a change in trench location made at requirement of Engineer involves abandonment of excavation already made, abandoned excavation, together with necessary refill is classed as unclassified excavation and backfill as applicable, in case full width of trench has not been abandoned.
3. If a change in trench location made at requirement of Engineer involves abandonment of excavation already made, abandoned excavation, together with necessary refill is classed as earth or rock excavation and backfill as applicable, in case full width of trench has not been abandoned.
4. If a changed location of a trench is authorized by Engineer upon Contractor's request, Contractor is not entitled to extra compensation or to a claim for damage. If change of trench location involves abandonment of excavation already made, abandoned excavation and refill is at Contractor's expense.

M. Classification of Excavated Materials: No consideration is given to nature of materials encountered in trenching operations. Therefore, no additional payment will be made for difficulties encountered in handling, disposal, or replacement of materials removed.

N. Bedding: Excavate trench and construct bedding as shown on the Construction Detail Drawings.
1. Excavate the trench to at least six inches below the required bottom of pipe. Excavate further if necessary, in the opinion of the engineer, to reach suitable material for support of the utility.

2. Place AASHTO #8 bedding material, compacting in 4" layers to cover the bottom one-quarter of the pipe. Hand shape a cradle conforming to the bottom of the pipe.

3. Fill the spaces beside and over the pipe to a depth of 12" above the top of pipe. Where the pipe is rigid, tamp this material in layers 4" thick. Where the pipe is corrugated metal or plastic storm sewer pipe, avoid tamping directly over the pipe. See the Construction Detail Drawings.

O. Backfill: Install backfill on top of the completed bedding as shown on the Construction Details and as follows:

1. In areas under lawn or otherwise not paved nor exposed to vehicular traffic, fill the trench to one foot below finished grade with suitable backfill obtained from site excavation or imported. Backfill must be compacted in layers not to exceed 6”.

2. Complete filling the trench to finish grade with topsoil.

3. In vehicular areas, fill the trench above bedding with AASHTO #57 Coarse Aggregate, compacted in 6” layers, to subgrade elevation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Reuse only materials free of topsoil, plant life, lumber, metal, refuse, coal waste, slag, and cinders. Remove all other material from the site.

B. Approved Backfill: On-site excavated soil or soil-rock mixed materials free of rocks or similar hard objects larger than six inches in any dimension. Rocks or similar hard objects may not represent more than 20 percent of backfill by volume.

C. Select Backfill: On site excavated material free of rocks or similar hard objects larger than one inch in any dimension.

D. AASHTO No. 57 Stone and as specified in Part 2.3.C of Section 31 20 00: Earth Moving.

E. Pipe Bedding: AASHTO No. 8 Stone and as specified in Part 2.3.C of Section 31 20 00: Earth Moving.

F. Concrete Cradle and Encasement: Per requirements of Section 03 30 53: Miscellaneous Cast-In-Place Concrete and of Class B: 3000 psi.

G. Underground Warning Tapes: Printed polyethylene metallic detection tape, six inches minimum width, color coded, one inch minimum lettering, printed with name of utility buried below, and suitable for installation in all soil types.

1. Provide detection tape for the following pipe lines and utilities as installed or encountered:
   a. Sanitary Sewers – Green
   b. Storm Sewers – Green
   c. Sewage Force Main – Green
   d. Water Line - Blue
   e. Gas Line – Yellow tape plus a tracer wire where indicated by the Utility
   f. Electric – Red
   g. Telephone – Orange
h. CATV Conduit – Orange
i. Petroleum Line - Yellow

H. Flowable Backfill:
1. Cement: Type I or II conforming to PENNDOT Section 701.
2. Fine Aggregate: Type A, B, or C conforming to PENNDOT Section 703.1, except having a maximum loss of 20 percent in the Soundness Test.
3. Coarse Aggregate: Type C or better, AASHTO No. 10, conforming to PENNDOT Section 703.2.
5. Admixtures: Conforming to PENNDOT Section 711.3. Can be used when specifically approved.
6. Mix Design (Per Cubic Yard):
   a. Provide design mix in accordance with PENNDOT 704.1 (c).
8. Compressive Strength (PTM No. 604):
   a. 3 days: 500 minimum.
   b. 28 days: 900.

END OF SECTION 31 23 33.13
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Provision for soil erosion and sedimentation control work as indicated on Drawings.

B. Related Sections:
1. Section 31 20 00: Earth Moving.
2. Section 31 22 00: Grading.
3. Section 31 23 33.13: Trenching and Backfilling for Site Utilities.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. ASTM A 82; Specification for Cold-Drawn Steel Wire for Concrete Reinforcement.
2. ASTM A 615; Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
4. ASTM D 3776; Standard Test Method for Mass Per Unit Area (Weight) of Woven Fabric.

B. Commonwealth of Pennsylvania Department of Transportation (PENNDOT) Specifications, Publication 408.
1. PENNDOT Section 703, Aggregates.
2. PENNDOT Section 735, Geotextiles.
3. PENNDOT Section 805, Mulching.
4. PENNDOT Section 806, Water Course and Slope Erosion Protection.
5. PENNDOT Section 850, Rock Lining.
6. PENNDOT Section 865, Silt Barrier Fence.

C. Commonwealth of Pennsylvania, Department of Environmental Protection (PADEP), Bureau of Soil and Water Conservation.
1. Erosion and Sediment Pollution Control Program Manual.
   a. Chapter 5, Standards and Specifications.
1.3 SUBMITTALS

A. Furnish certificates from manufacturers of following materials, certifying their products meet requirements of these Specifications.
   1. Matting for Erosion Control.
   2. Fabric for Silt Barrier Fencing.

1.4 PROJECT CONDITIONS

A. Environmental Requirements:
   1. See applicable section for environmental protection, erosion control general requirements, and scheduling.

PART 2 - PRODUCTS

2.1 STONE FOR RIPRAP

A. Provide riprap obtained from an offsite source from an approved PENNDOT Type A source. Do not use stone for riprap protection containing boulders, or cobbles from soil or gravel deposits, earth, roots, debris, or similar material. Each stone to weigh not less than 162 pounds per cubic foot, based on saturated dry specific gravity, determined in accordance with ASTM C 97.

B. Provide stone that is predominantly angular and blocky in shape rather than elongated, with sharp clean edges at intersection of relatively flat faces. Following shape limitations are specified for stone used for riprap protection.
   1. Not more than 25 percent of stones reasonably well distributed throughout gradation to have a length more than 2.5 times breadth or thickness.
   2. Do not use stone having a length exceeding 3.0 times its breadth or thickness.

C. Stone for riprap protection obtained from an offsite source to conform to gradation requirements for Rock Lining as specified in PENNDOT Section 850. "R" classification is as indicated on Drawings. Stone protection material may contain up to 5 percent, by weight of air dried rock, fragments, spalls, and dust with each particle weighing less than permissible minimum stone size and be defined as a stone in stone protection material. In computing percentages by weight of stones in required gradation, do not include weight of a particle weighing less than permissible minimum stone size in total weight.

2.2 MATTING FOR EROSION CONTROL

A. Jute Matting: PENNDOT Section 806.2(a)1.

B. Wood Excelsior Blanket: PENNDOT Section 806.2(a)2.

C. Mulch Control Netting: PENNDOT Section 806.2(d).

D. Nylon Erosion Control Mat: PENNDOT Section 806.2(b)2.

E. Staples: PENNDOT Section 806.2(e).

2.3 EROSION CONTROL DEVICES

A. Straw Bale Barriers:
1. **Bales**: Straw stalks of threshed grain or tall hay grass stalks commercially available locally.
2. **Stakes**: Wood Stakes. Sound, rough sawn, red, or white cedar or hardwood measuring two inches by two inches; of required length, with tapered point.
3. **Reinforcement Bars**: ASTM A 615 (S1), Grade 60, Deformed.

B. **Wire**: ASTM A 82.

C. **Filter Fabric Fence**: PENNDOT Section 865.2.

D. **Rock Construction Entrance**:  
   1. **Crushed Stone**: PENNDOT Section 703.2, AASHTO No. 1.  
   2. **Filter Cloth**: PENNDOT Section 735, Class 4.

E. **Pumped Water Sediment Control Device (PWSCD)**:  
   1. Nonwoven geotextile fabric sewn with double needle machine using high strength thread.  
   2. Provide PWSCD with opening large enough to accommodate a 4 inch discharge hose with attached strap to tie off the hose preventing pumped water from escaping from PWSCD without being filtered.
   3. **Properties**:  
      | PROPERTY       | TEST METHOD    | TEST RESULT |
      |----------------|----------------|-------------|
      | Weight         | ASTM D 3776    | 10 oz./yd.  |
      | Grab Tensile   | ASTM D 4632    | 270 lbs.    |
      | Puncture       | ASTM D 4833    | 150 lbs.    |
      | Flow Rate      | ASTM D 4491    | 70 gal./min./ft.² |
      | Permittivity   | ASTM D 4491    | 1.3 sec⁻¹   |
      | UV Resistance  | ASTM D 4355    | 70%         |
      | AOS % Retained | ASTM D 4751    | 100         |
      | Seam Strength  | ASTM D 4884    | 100 lbs./in.|

   All properties are minimum average roll value except the weight of the fabric which is given for information only.

4. **Manufacturer**:  
   a. ACF Environmental, Dirtbag.  
   b. Or approved equal.

F. **Inlet Sediment Control Device (ISCD)**:  
   1. Woven geotextile fabric sack sewn with double needle machine using high strength thread. Geotextile fabric sack to have an average wide width strength of 100 lb/in per ASTM D 4884.  
   2. Provide ISCD manufactured to fit openings of the inlets.  
   3. Provide ISCD with integral dump straps, lifting loops and restraining strap.  
   4. **Properties**.
### PROPERTY TEST METHOD TEST RESULT

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<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>TEST RESULT</th>
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<tbody>
<tr>
<td>Grab Tensile</td>
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<tr>
<td>Grab Elongation</td>
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<td>Puncture</td>
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<td>Mullen Burst</td>
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<td>Trapezoid Tear</td>
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<td>UV Resistance</td>
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<td>Apparent Opening Size</td>
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<td>40 US Sieve</td>
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<td>Permittivity</td>
<td>ASTM D 4491</td>
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</table>

All properties are minimum average roll values.

5. Manufacturer:
   a. ACF Environmental, Silt sack.
   b. Or approved equal.

G. Channel Inlet Protection: DEP Erosion and Sediment Pollution Control Program Manual Details and Notes and Detail Drawings.

H. Curbed Roadway Inlet Protection: DEP Erosion and Sediment Pollution Control Program Manual Details and Notes and Detail Drawings.

I. Rock Filters: DEP Erosion and Sediment Pollution Control Program Manual, Chapter 5, Section 11.

### 2.04 TEMPORARY SEEDING MIXTURES

A. As indicated on the Drawings.

<table>
<thead>
<tr>
<th>Variety of Seed</th>
<th>Spring Mar. 1-May 15 (lb. per acre)</th>
<th>Summer May 15-Aug. 15 (lb. per acre)</th>
<th>Fall &amp; Winter Aug. 15-Mar. 1 (lb. per acre)</th>
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<td>Annual rye grass</td>
<td>20</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>Barley or Oats (local seed)</td>
<td>96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Millet (Japanese)</td>
<td></td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Annual rye grass</td>
<td></td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>Winter rye or</td>
<td></td>
<td></td>
<td>168</td>
</tr>
</tbody>
</table>
### Varieties of Seed for Planting

<table>
<thead>
<tr>
<th>Variety of Seed</th>
<th>Spring (Mar. 1-May 15)</th>
<th>Summer (May 15-Aug. 15)</th>
<th>Fall &amp; Winter (Aug. 15-Mar. 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter wheat</td>
<td>lb. per acre</td>
<td>lb. per acre</td>
<td>180</td>
</tr>
</tbody>
</table>

### 2.5 SOIL SUPPLEMENT MATERIALS

**A.** As specified in Section 31 22 19: Finish Grading.

### 2.6 MULCHING MATERIALS

**A.** Mulches: As specified in PENNDOT Section 805.2(a)1.

**B.** Mulch Binding: As specified in PENNDOT Section 805.2(b).

**C.** Wood Chips: Wood chips, recovered from clearing and grubbing operations is acceptable as mulch for seeding and used at a rate of 35 cubic yard per acre.

### PART 3 - EXECUTION

### 3.1 INSTALLATION

**A.** Bedding Material for Riprap: Place bedding material uniformly on prepared base, in a satisfactory manner, over areas to receive riprap and to a minimum thickness of 6 inches. Repair damage to surface of bedding base during placement of bedding material or riprap before proceeding with work. Compaction of bedding is not required, but finish to present a reasonably even surface, free from wounds or windows.

**B.** Riprap: Firmly bed each stone abutting against other stones to form a layer, with interstices filled with suitably sized spalls. Take care in placing stone so that its weight is carried by underlying material and not by adjacent stones. Surface of each stone is not to vary more than four inches from surface plane. Depths of abutting stones are not to differ by more than 4 inches. Progress by fitting additional and abutting stones with well broken joints so that most compact mass of riprap is developed.

**C.** Trench Plugs:

1. Provide temporary trench plugs at intersections between interceptor terraces and open pipeline trench to prevent unconsolidated soils from being washed down trench during periods of rainfall. Temporary trench plugs consist of eight foot long dams of compacted earth.
2. Provide permanent trench plugs on critical slopes and on each side of creek crossings to form a solid barrier against subsurface water movement. Permanent trench plugs consist of earth filled sacks packed tightly around pipe.

**D.** Silt Barrier Fence: Install fence near limits of excavation or fills where indicated on Drawings or as directed by Engineer to control erosion until disturbed areas are permanently stabilized.

1. Construct silt barrier fencing with Class 3 geotextile material with wire or plastic mesh support fencing fastened to support posts. Overall height of fabric above ground to be nominally 18 inches. Provide geotextile material of width required including an 8 inch to 12 inch section for embedment.
2. Excavate a trench 6 inches wide by 6 inches deep on fabric side of barrier and along inside of post line.
3. Install posts a minimum of 18 inches deep, by an approved method, on downstream edge of trench at a maximum spacing of 10 feet.
4. Provide wire or plastic mesh support fence when used, of sufficient height to extend from top of fabric to ground or into excavated trench and be securely fastened to posts. Provide staples for wood posts and tie wires for steel and plastic posts, with a minimum of three fasteners per post.
5. Secure geotextile fabric material by fasteners to top of wire mesh and posts, keeping sag to a minimum, and at a maximum spacing of 30 inches. Extend fabric 8 to 12 inches into excavated trench for embedment. Backfill and compact over geotextile material to prevent water from flowing under fabric. Overlap fabric roll ends a minimum of 6 inches at post locations.
6. Preassembled silt barrier fence systems to be approved by Engineer. Install preassembled fence systems in accordance with manufacturer's recommendations.
7. Construct silt barrier fence across a ditch or swale area of sufficient length to eliminate end flow, with ends pointing upstream and upslope.
8. Maintain silt barrier fence satisfactorily to keep functional. This includes removal of trapped sediment and cleaning fabric of trapped sediment by tapping fabric material when dry. Replace fabric not functioning due to clogging, damage, or deterioration as directed by Engineer.
9. Remove fencing when no longer required, as determined by Engineer. Dispose of fencing materials in a suitable manner and restore area where fence had been erected at no additional cost to Owner.

E. Pumped Water Sediment Control Device (PWSCD):
1. Install the PWSCD on a slope. It should be placed so the incoming water flows into the bag and will flow through the PWSCD and then flow off the site without creating more erosion. The neck of the PWSCD should be tied off tightly to stop the water from flowing out of the PWSCD without going through the walls of the bag. To increase the surface area being used, the PWSCD may be placed on a gravel bed to allow water to flow in all directions.
2. The PWSCD is considered full and should be disposed when it is impractical for the bag to filter the sediment out at a reasonable flow rate and should be replaced with a new PWSCD.
3. Disposal may be accomplished as directed by the Engineer. If the site allows, the PWSCD may be buried on site and seeded, visible fabric removed and seeded or removed from site to a proper disposal area.

F. Inlet Sediment Control Device (ISCD):
1. Installation and emptying instructions in accordance with manufacturers printed instructions.

G. Temporary Seeding and/or Mulching:
1. General: Engineer reserves right to direct temporary seeding and/or mulching of disturbed areas in event permanent grading and seeding cannot be immediately performed. Include cost of temporary erosion control measures in appropriate pay item.
2. Liming: Lime application rates will be determined on basis of tests performed by Contractor or apply a minimum of 800 pounds of agricultural lime stone per 1000 square yards.
3. Fertilizer: Apply fertilizer at a rate of 140 pounds per 1000 square yards of 10-20-20 fertilizer or in conformance with results of soil tests performed.
4. Tilling: Till seedbed to a depth of 3 inches prior to seeding. Lime (if required) and fertilizers may be applied during tilling operation.
5. **Seeding:** Type of temporary seed mixture to be used is determined by Engineer. Sow seed at rate indicated in Temporary Seeding Mixtures Article. Cover seed with 1/2 inch of topsoil and lightly roll seeded area.

6. **Mulching:** Apply hay or straw mulch at rate of three tons per acre on slopes of 1.5 to 1 or flatter. Apply asphalt material to anchor mulch at rate of 50 gallons per ton on straw or hay mulch. Apply wood cellulose fiber mulch on slopes steeper than 1.5 to 1 at a rate of 1500 pounds per acre. Wood chips, recovered from clearing and grubbing operations, is acceptable as mulch for temporary seeding. Use at a rate of 35 cubic feet per acre in lieu of straw or hay.

H. **Mulching Alone:** For embankments or cuts 1.5 to 1 or flatter, susceptible to critical erosion during periods of cold weather or other site conditions, Engineer may require a three ton per acre application of straw or hay mulch for temporary erosion control and later seeding. Apply asphalt for anchoring mulch at a rate of 50 gallons per ton. Straw or hay may be rolled immediately with a sheepsfoot roller to anchor mulch in lieu of using asphalt. When weather becomes favorable, seed areas provided with a mulch cover alone using normal application rates of seed, fertilizer, and lime. If additional mulch is needed, rate of application and area to be mulched will be as determined by Engineer.

I. **Matting for Erosion Control:** Provide matting in lieu of mulch on slopes 3:1 and steeper or when directed by Engineer.
   1. Prepare area to be covered as a fine seedbed, fertilized, and seeded. Place matting immediately and water to give a firm bond to soil and start germination of seed. Either jute or excelsior matting may be used.
   2. **Jute Matting:** Lay jute matting snugly to ground with a 4-inch overlap on edges and a 12-inch overlap on ends. Make check slots from a 2-foot-wide strip of jute matting folded and buried in a 6-inch-deep trench with a 6-inch flap extending on each side of trench. Place check slots perpendicular to water flow, tamped and stapled in place before jute matting is laid. Use check slots for jute matting when slope exceeds a 5 percent grade. On grades or slopes steeper than 5 percent, Engineer will determine spacing of check slots.
   3. **Excelsior Matting:** Lay excelsior matting with netting on top and fibers in contact with soil over entire area. Butt ends and sides of excelsior blanket snugly and staple. It is not necessary to dig check slots, anchor ditches, or bury ends of excelsior matting.
   4. **Staples:** Hold matting in place by means of wire staples driven at a 90-degree angle to soil surface. Space staples not more than 3 feet apart in three rows for each strip, with one row along each edge and one row alternately spaced in middle. Space staples 6 inches apart across matting ends and check slots width.

3.2 **MAINTENANCE**

A. Begin maintenance operations immediately and continue throughout construction period until Contract is completed. Inspect sediment control structures and repair after each storm.

3.3 **SOIL EROSION AND SEDIMENTATION PLAN**

A. An approved Erosion and Sedimentation Control Plan is indicated on Drawings. Should Contractor desire to modify this Plan, obtain necessary approvals prior to implementing any provisions at no additional cost to Owner.
SECTION 31 41 00 - SHORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The work specified in this Section consists of providing shoring which conforms to federal, state, and local laws, rules, regulations, requirements, precautions, orders, and decrees.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Shoring materials and installation work shall conform to Federal, State and local laws, rules, regulations, requirements, precautions, orders, and decrees. These include, but are not limited to,
   1. Occupational and Safety Health Administration (OSHA), Construction Standards for Excavation (29 CFR 1926.650 to .652)
   2. OSHA, Technical Manual

The duty or responsibility for inspection, determination, compliance, and enforcement of Federal, State, and local laws, rules, regulations, requirements, precautions, orders and decrees, rests with such department or agency and not with the Owner or Engineer.

B. Shoring Design: The design and the adequacy of the shoring installed is the responsibility of the Contractor.

1.3 SITE CONDITIONS

A. Responsibility for Condition of Excavation: The Contractor is solely responsible for the condition of the excavations.
   1. The failure or refusal of the Engineer to suggest the use of Shoring, or a better quality, grade, or section, or larger sizes of Shoring materials, or to suggest that Shoring be left in place, shall in no way or extent relieve the Contractor of his responsibility concerning the condition of excavation or of his obligations under the Contract, nor impose liability on the Engineer or the Owner.
   2. No delay, whether caused by an action or want of action on the part of the Contractor, or by an act of the Engineer, Owner, or their agents, or employees, resulting in the keeping of any excavation open longer than would otherwise have been necessary, shall relieve the Contractor from the necessity of properly and adequately protecting the excavation from caving or slipping, nor from his obligations under the Contract relating to injury to persons or property, nor entitle him to claims for extra compensation.

B. Shoring of Excavations: In order to help minimize the impact of excavations on adjacent structures, utilities, roadways, plantings, and sidewalks, the Contractor shall be required to install permanent shoring, as necessary, to prevent movement of such structures. Permanent sheeting shall be left in place at the end of construction, unless otherwise directed by the Engineer.
   1. It is the Contractor’s responsibility to assess the relevant subsurface and loading conditions at the locations where shoring is required, and to design, install, and maintain support systems which will prevent detrimental movement of adjacent soils or structures.
   2. Groundwater may be encountered during excavation. The Contractor is responsible for preventing migration of soils retained by shoring due to groundwater inflow or other
means. Shoring shall be adequately tight to ensure minimal migration of retained soils into excavations. The Contractor shall replace any soils that migrate due to groundwater inflow or other means and at no increase in the Contract Price.

3. The Contractor shall repair damage to utilities, which in the opinion of the Construction Manager and/or Engineer, was caused by shoring or shoring-related installations, or ground movement associated with adjacent excavation(s). Repair such damage to the Owner’s satisfaction and at no increase in the Contract Price.

4. The Contractor shall repair damage to structures, which in the opinion of the Construction Manager and/or Engineer, was caused by shoring or shoring-related installations, or ground movement associated with adjacent excavation(s). Repair such damage to the Owner’s satisfaction and at no increase in the Contract Price.

C. Tight Sheeting Requirements Concerning Piping and Conduits: In order to reduce backfill material pressures exerted on pipe lines and conduit runs (and their associated in-line structures, if any) which are located within the excavation limits for building foundations or other structure foundations, the Contractor shall have the option to provide either of the following:

1. Option One: For excavations deeper than five feet, provide tight sheeting from top of original grade to below planned structure foundation subgrade, except for excavations where stable rock is encountered. If stable rock is encountered at a depth greater than five feet but above the structure foundation subgrade, carry tight sheeting to top of rock.

2. Option Two: For excavations deeper than five feet, omit tight sheeting, slope the excavation, and provide Select Granular Material on undisturbed earth up to the level of pipe bedding and conduit bedding (or encasement) with such material being placed in eight-inch compacted layers.
   a. Select Granular Material shall conform to the Commonwealth of Pennsylvania Department of Transportation, Specifications Publication 408, as supplemented, Section 703.3.

3. No increase in Contract Price will be allowed for either option. Additionally, regardless of the option selected, the responsibility for the condition of excavation remains the Contractor’s responsibility.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Shoring materials shall conform to Federal, State and local laws, rules, regulations, requirements, precautions, orders, and decrees.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Shoring installations shall conform to Federal, State and local laws, rules, regulations, requirements, precautions, orders, and decrees.

B. Shoring Left in Place: The Contractor shall have no claim for additional compensation for shoring left in place at his volition and without the Engineer’s written requirement.

C. Cut off excess portions of shoring left in place whenever and at such points as the Engineer shall require, and remove from the work the portion cut off. No additional compensation shall be paid for such shoring cutting and removal.
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SECTION 32 10 00 - PAVING AND SURFACING [C]

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The work specified in this Section consists of the paving and repaving operations for the areas indicated for new bituminous paving.

B. Related Sections:
1. Section 31 20 00: Earth Moving.
2. Section 31 22 19: Finish Grading.
3. Section 31 23 33.13: Trenching and Backfilling for Site Utilities.
4. Section 03 30 53: Miscellaneous Cast-In-Place Concrete.
5. Section 32 16 13.16: Cast-in-Place Concrete Curbs.
6. Section 32 12 00: Asphalt Overlay Paving.

1.2 REFERENCES

A. PENNDOT References: The PENNDOT Sections noted herein refer to sections contained in the Commonwealth of Pennsylvania Department of Transportation (PENNDOT) Specifications Publication 408, as supplemented. The payment provisions do not apply to work to be performed under this Specifications Section.
1. PENNDOT Section 305 Bituminous Concrete Base Course.
2. PENNDOT Section 350 Subbase.
3. PENNDOT Section 401 Plant Mixed Bituminous Concrete Courses.
4. PENNDOT Section 403 Recycled Plant-Mixed Bituminous Concrete Courses.
5. PENNDOT Section 420 Bituminous Wearing Course ID-2 and Bituminous Wearing Course ID-2, RPS.
6. PENNDOT Section 421 Bituminous Binder Course ID-2 and Bituminous Binder Course ID-2, RPS.
7. PENNDOT Section 460 Bituminous Tack Coat.
8. PENNDOT Section 461 Bituminous Prime Coat.
9. PENNDOT Section 491 Milling of Bituminous Pavement Surface.
10. PENNDOT Section 702 Bituminous Material.
11. PENNDOT Section 703 Aggregates.
12. PENNDOT Section 962, Painting Traffic Lines and Markings.

B. Commonwealth of Pennsylvania Department of Transportation Bulletin 25 and Bulletin 27.

C. American Society for Testing and Materials (ASTM):
2. ASTM D 2167, Test Method for Density of Soil in Place by the Rubber-Balloon Method.

D. American Association of State Highway and Transportation Officials (AASHTO):
1. AASHTO T 180, Moisture-Density Relations of Soils Using a ten pound Rammer and an 18-inch Drop.

1.3 DEFINITIONS

A. Specified Maximum Trench Width: The applicable maximum trench width as shown on the Contract Drawings.
B. Street: Unless otherwise specifically qualified herein, the term Street as used in this Section is understood to mean a street, highway, avenue, boulevard, road, alley, lane, driveway, parking lot, or any other area used as a way for vehicles.

1.4 QUALITY ASSURANCE

A. Source Quality Control: Maintain the quality of work by using the products of a qualified bituminous concrete producer and qualified plant operating workmen.
1. Use products of a bituminous concrete bulk producer regularly engaged in production of hot-mix, hot-laid bituminous concrete conforming to the standards referenced herein.
2. Use materials conforming to the requirements of the Commonwealth of Pennsylvania Department of Transportation Specifications Publication 408, as supplemented.

B. Workmen Qualifications: Provide at least one person thoroughly trained and experienced in the skills required and who readily understands the design and is completely familiar with the application of bituminous concrete paving work.
1. During progress of bituminous concrete paving work the trained person shall be present to direct the performance of work.
2. For actual finishing of bituminous concrete surfaces and operation of the equipment, use only personnel thoroughly trained and experienced in the skills required.

1.5 PROJECT CONDITIONS

A. Environmental Requirements:
1. Dust Control: Provide effective dust control by sprinkling water, by the use of calcium chloride, or by other methods as approved by the Engineer. Use dust control measures where and when, and in a manner as required by the Engineer.
2. Temperature Limitations: Terminate placement of bituminous concrete surface courses of permanent pavement between October fifteenth and thirty-first, and do not resume placement prior to April first to fifteenth; interim days between date limits may be used for placement as determined by the Engineer depending upon weather temperature conditions.
   a. Do not install aggregate courses when ambient temperature is below or is expected to fall below freezing.
   b. Do not use aggregate containing frost nor place aggregate courses on frozen subgrade.
   c. Do not place bituminous concrete surface courses of permanent pavement when the ambient temperature is 40 degrees F. or lower; nor when the temperature of the pavement, base or binder on which it is to be placed is 40 degrees F. or lower.
3. Paint Application Limitations: Adhere to manufacturer’s data on air and surface temperature limits and relative humidity during application and curing of coatings.
   a. Do not spray- apply paint when wind velocity is above 15 mph.
   b. Schedule painting work to avoid dust and airborne contaminants.
   c. Apply paint during daylight hours only.

PART 2 - PRODUCTS

2.1 BASE COURSE MATERIALS [C]

A. Subbase: Composed of Coarse Aggregate Type C (or better) stone conforming to PENNDOT Section 703.2, No. 2A coarse aggregate and as specified in Part 2.3.C of Section 31 20 00: Earth Moving. [C]

B. Bituminous Concrete Base Course: Conforming to PENNDOT Section 305 and Section 403 for RAP requirements.
C. Bituminous Material: Use one of the following conforming to PENNDOT Section 702 and Bulletin 25.

2.2 SURFACE COURSE MATERIALS

A. Bituminous Materials:
   2. Bituminous Tack Coat: Class E-1, E-6, or E-8 emulsified asphalt conforming to PENNDOT Bulletin 25.
   3. Bituminous Prime Coat: Conforming to bituminous material requirements of PENNDOT Section 461.2(a).

B. Bituminous Pavement Materials:
   1. Wearing Course: Hot mixed, hot laid, Bituminous Wearing Course ID-2: Conforming to PENNDOT Section 420.

C. Traffic Zone Paint: Provide products meeting requirements of PENNDOT Section 962 for the following:

2.3 MISCELLANEOUS MATERIALS

A. Traffic Zone Paint: PENNDOT Section 704:
   1. Yellow Traffic Zone Paint: Low-heat, rapid-dry formulation for center lines; reflective.
   2. White Traffic Zone Paint: Low-heat, rapid-dry formulation for edgelines and stop bars; reflective.
   3. Paint Quality: Paint material composition shall conform to AASHTO Type F paint formulation and AASHTO M-247, Type (standard gradation) for reflective media (glass beads).

2.4 PAVEMENT MIXES

A. Composition of Mixtures: Binder and wearing course mixture composition shall conform to the requirements of PENNDOT Section 401.
   1. Establish a job-mix formula prior to beginning work which shall not be changed during the progress of work without the Engineer’s approval. Job-mixing tolerances shall not be presumed to permit acceptance of materials whose gradations fall outside the master ranges set in the specified PENNDOT Sections.
   2. The approved job-mix formula shall lie within the specification limits and be suitable for the layer thickness and other conditions prevailing. It shall not be changed after work has started without the approval of the Engineer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Subgrade Preparation: Just prior to subbase installation, as specified in Section 31 20 00: Earth Moving, perform grading and finish rolling.
   1. Perform subgrade preparation only after site grading, trenching, etc., have been completed and accepted by the Engineer.
   2. The moisture content of the subgrade material at the time of compaction shall not exceed two percentage points above the optimum moisture content.
3. Subgrade over Trenches: Backfill and compact trenches as specified in Section 31 33.13: Trenching and Backfilling for Site Utilities.

B. General Requirements for Pavement Removal: Cut existing pavement to neat lines with a mechanical saw.
   1. At joints between existing pavements and new paving work, cut and neatly trim the edges of existing pavements in a manner subject to the Engineer’s approval. Provide an application of Class AC-20 petroleum asphalt at the locations where new bituminous paving joins existing bituminous paving.

3.2 PERMANENT PAVING INSTALLATION

A. General Requirements: Methods of preparing paving mixture, placing paving mixture, compaction, and protection of in-place bituminous concrete pavement shall comply with PENNDOT Sections 305.3 and 401.3. The specified thicknesses are the compacted thicknesses.
   1. Location of types and thicknesses of pavements are delineated on Drawings.
   2. Install surface course of replacement pavement with top surface flush with surface of adjacent pavement.

B. Base Course Installation:
   1. Bituminous Concrete Base Course: Construct in accordance with the requirements of PENNDOT Section 305.

C. Binder Course Installation:
   1. Bituminous Concrete Binder Course: Construct in accordance with the requirements of PENNDOT Section 421.

D. Wearing Course Installation:
   1. Bituminous Concrete Wearing Course: ID-2, construct in accordance with the requirements of PENNDOT Section 420.
      a. Use Bituminous Tack Coat material to seal joints in wearing courses as specified in PENNDOT Section 401.3 (j) 3.

3.3 MISCELLANEOUS MATERIALS INSTALLATION

A. Cement Concrete Curbs: Curbs to shape, thickness, workmanship and finish as delineated on drawings and per referenced specifications unless otherwise required by the Engineer. Construction methods as specified in PENNDOT Section 630.

3.4 PAVEMENT MARKING

A. Paint Application: Strictly follow paint manufacturer's label instructions for mixing, thinning, proper spreading rate, and drying time. In no case shall film thickness be less than manufacturer's recommendations nor shall area coverage per gallon exceed manufacturer's recommendations.
   1. Preparation: Prior to pavement marking, clean pavement surface free of contaminants that will prohibit paint adhesion.
   2. Thinning: If material has thickened or must be diluted for application, the coating shall be built up to the same film thickness achieved with undiluted material. Do not use thinner to extend coverage of the paint.
   3. Coverage Rate: Regardless of the surface condition, apply paint to achieve a suitable finish either by decreasing the coverage rate or by applying additional coats of paint.
   4. Provide temporary satisfactory barriers for at least 30 minutes, or until the paint is dry and track free from vehicular traffic. Repaint marked or damaged areas.
B. Parking Area Traffic Lines and Markings: Striping shall consist of white four-inch wide painted lines of length and spacing indicated on the Drawings. Paint lines accurately with sharp, clearly defined edges. Paint solid colored areas free of skips and holidays. Make linework straight and uniformly spaced.

3.5 MAINTENANCE

A. Continuously maintain temporary pavement without additional compensation until it is replaced with permanent pavement.

B. Without an increase in Contract Price, maintain the work done under this Section for a period as stated in the Agreement after the date of the Owner’s approval of the Substantial Completion Certificate issued by the Engineer. Maintenance shall include the repair or removal and replacement of such work which has failed, or wherever surface depressions have developed. Materials and methods used to repair or replace such work shall conform to the applicable requirements of this Section.

C. Should the Contractor fail to perform required maintenance or repairs within three days after receiving written notice from the Owner or Engineer, the Owner may perform such maintenance or repairs and deduct the cost thereof from monies due or to become due the Contractor.

END OF SECTION 32 10 00
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The work specified in this Section consists of the overlay paving operations for the areas indicated on the Contract Drawings.

B. Related Sections:
1. Section 31 23 33.13: Trenching and Backfilling for Site Utilities.
2. Section 32 10 00: Paving and Surfacing.

1.2 REFERENCES

A. The PENNDOT Sections noted herein refer to sections contained in the Commonwealth of Pennsylvania Department of Transportation (PENNDOT) Specifications Publication 408, as supplemented. The payment provisions do not apply to work to be performed under the Contract.
1. PENNDOT Section 401 Plant Mixed Bituminous Concrete Courses.
2. PENNDOT Section 420 Bituminous Wearing Course ID-2 and Bituminous Wearing Course ID-2, RPS.
3. PENNDOT Section 421 Bituminous Binder Course ID-2 and Bituminous Binder Course ID-2, RPS.
4. PENNDOT Section 460 Bituminous Tack Coat.
5. PENNDOT Section 461 Bituminous Prime Coat.
6. PENNDOT Section 470 Bituminous Seal Coat.
7. PENNDOT Section 480 Bituminous Surface Treatment.
8. PENNDOT Section 501 Reinforced or Plain Cement Concrete Pavements.
9. PENNDOT Section 692 Traffic Lines and Markings

B. PENNDOT Bulletin 25.

1.3 DEFINITIONS

A. Specified Maximum Trench Width: The applicable maximum trench width shown on the Contract Drawings.

B. Street: Unless otherwise specifically qualified herein, the term street as used in this Section is understood to mean a street, highway, avenue, boulevard, road, alley, lane, driveway, parking lot, or any other area used as a way for vehicles.

1.4 QUALITY ASSURANCE

A. Source Quality Control: As specified in Section 32 10 00.

B. Workmen Qualifications: As specified in Section 32 10 00.

C. Requirements of Regulatory Agencies: As specified in Section 32 10 00 with the following additional requirement.
1. Unless otherwise specified or required by the Engineer, overlay paving work will not be permitted until all other work to be performed under the Contract has been completed.
1.5 PROJECT CONDITIONS

A. Environmental Requirements: As specified in Section 32 10 00.

B. Time Requirements: As specified in Section 32 10 00.

PART 2 - PRODUCTS

2.1 SURFACE COURSE MATERIALS

A. Bituminous Materials:
   2. Bituminous Tack Coat: Class E-1, E-6 or E-8 emulsified asphalt conforming to PENNDOT Bulletin 25.
   3. Bituminous Prime Coat: Conforming to bituminous material requirements of PENNDOT Section 461.2(a).

B. Bituminous Pavement Materials:
   1. Binder Course: Hot mixed, hot laid, Bituminous Binder Course ID-2 conforming to PENNDOT Section 421, using asphalt cement.
   2. Wearing Course: Hot mixed, hot laid, Bituminous Wearing Course ID-2: Conforming to PENNDOT Section 420.
   3. Bituminous Seal Coat: Conforming to PENNDOT Section 470.2.
   4. Bituminous Surface Treatment: Conforming to PENNDOT Section 480.2.

2.2 PAVEMENT MIXES

A. Composition of Mixtures: Binder and wearing course mixture composition shall conform to the requirements of PENNDOT Section 401.
   1. Establish a job-mix formula prior to beginning work which shall not be changed during the progress of work without the Engineer's approval. Job-mixing tolerances shall not be presumed to permit acceptance of materials whose gradations fall outside the master ranges set in the specified PENNDOT Sections.
   2. The approved job-mix formula shall be within the specification limits and be suitable for the layer thickness and other conditions prevailing. Do not change the formula after work has started without the approval of the Engineer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation of Existing Paving:
   1. Prior to overlay paving, condition the existing paving in accordance with PENNDOT Section 401.3(g).

B. Patching Existing Paving:
   1. Prior to overlay paving, patch potholes and other damaged areas in the existing paving. The location and extent of the pavement patching will be determined by the Engineer.
   2. Prior to overlay paving, level low and depressed areas on roadways. Location and extent of leveling will be determined by the Engineer.
3. Thoroughly clean and remove loose material, dry and prime with a light coat of emulsified asphalt areas to be patched or leveled.

4. Use (Bituminous Binder Course) (Bituminous Wearing Course ID-2) material placed by hand, spread with rakes, lutes, brooms or shovels to obtain uniform placement. Use hand operated vibratory compactor or similar equipment for compaction. When approved by Engineer, mechanical pavers or conventional power rollers may be used in areas requiring leveling.

5. When patch exceeds one-inch in depth, cut the edges of pavement square and vertical to provide mechanical shoulder.

C. Adjustment of Height of Gas and Water Service Boxes and Frames of Underground Structures:
1. Adjust the heights of gas and water service boxes and frames of other underground utility structures if they are existing within the limits of overlay paving. Adjust these boxes and frames to the new finish grade elevations of the overlay paving.
2. Make the necessary arrangements with the respective utility companies for adjustment of their service boxes and frames of underground structures.
3. Do not proceed with the overlay paving until the heights of service boxes and frames of underground structures have been adjusted to the satisfaction of the Engineer.
4. No separate or additional payment will be made for adjusting the heights of service boxes, and frames of other underground structures, it being understood and agreed that such costs be included in the Contract unit price per square yard for furnishing and placing the overlay paving.

D. Painting Curbs: Prior to placing the bituminous concrete overlay pavement, paint the inside faces of existing curbs below the reveal with a thin application of asphalt cement to provide a closely bonded, watertight joint.

E. Tack Coat: Prior to placing the bituminous concrete overlay pavement, apply a Bituminous Tack Coat consisting of a thin application of emulsified asphalt to the existing paved surface at such rate and in such manner as set forth in PENNDOT Section 460. Prior to applying the tack coat, clean loose and foreign material from existing pavement surface.

F. Make joints of overlay pavement as specified in PENNDOT Section 401.3 (j).

G. At joints between existing pavement and new paving work, cut the edges of existing pavements neatly trimmed as approved by the Engineer. Cut paving with a mechanical saw. Apply asphalt cement at locations where new bituminous paving joins existing bituminous paving.

3.2 INSTALLATION

A. General Requirements: Method of placing, compacting and the protection of in-place bituminous concrete for pavement shall comply with PENNDOT Section 401.3.

B. Limits of Overlay Paving: Provide overlay pavement to the limits specified herein and to such additional limits as required by other agencies having jurisdiction, or the Engineer.
1. Provide overlay pavement for existing access roads, service roads, parking areas and sidewalks on site as indicated on the Drawings.

C. Overlay Paving, Bituminous Wearing Course ID-2:
1. Use materials, composition of mixture and methods to construct the bituminous concrete overlay paving conforming to the applicable requirements of PENNDOT Section 420 for Bituminous Wearing Course ID-2.
2. Minimum thickness of overlay pavement after compaction shall be the greater of:
   a. One inch (1”).
   b. The depth of milling.
3. Install a leveling course of bituminous material in depressions as required and as specified herein.
   a. Include the cost of this extra thickness in the cost of overlay paving. No separate or additional payment made for installing leveling course

3.3 MAINTENANCE

A. As specified in Section 32 10 00 with the exception of maintaining temporary paving.

B. Should the Contractor fail to perform required maintenance or repairs within three days after receiving written notice from the Owner or Engineer, the Owner may perform such maintenance or repairs and deduct the cost thereof from any monies due or to become due the Contractor.

END OF SECTION 32 12 00
SECTION 32 1400 - UNIT PAVING [C]

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Brick pavers set on sand setting beds on a concrete base for the Garden Seating Area.
   2. Cut-stone pavers set in mortar setting beds on concrete base for the Entries and Lawn Terrace Area.

B. Related Sections include the following:
   1. Division 03 Section 03 3000 Cast-in-Place Concrete, for installation of the paver base.

1.2 SUBMITTALS

A. Product Data: For the following:
   1. Brick Pavers.
   2. Cut Granite Pavers.
   3. Joint Sealant

B. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.

C. Samples for Initial Selection: For the following:
   1. Each type of unit paver indicated.
   2. Joint materials involving color selection.
   3. Granite sample for curb color.

D. Samples for Verification:
   1. Full-size units of each type of unit paver indicated.
   2. Joint materials.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
2. Size and locations to be determined.

C. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquids in tightly closed containers protected from freezing.

1.5 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or aggregate setting beds. Remove and replace unit paver work damaged by frost or freezing.

PART 2 - PRODUCTS

2.1 REGIONAL MATERIALS

A. Provided regional materials for LEED compliance wherever possible: mortar aggregate mortar cement and lime grout aggregate and grout cement

2.2 BRICK PAVERS

A. Glen Gery Brick Pavers:
   1. Non-modular molded 53-DD
   2. Color: Full range
   3. Thickness: 2-1/4 inches
   4. Face Size: 4 by 8 inches non-modular

B. Efflorescence: Brick shall be rated "not effloresced" when tested according to ASTM C 67.

2.3 STONE PAVERS AND BANDS

A. Dimensional Cut Granite Pavers: Type 1A
   1. Manufactured by North Carolina Granite, Inc, or equal.
   2. Use: Entries and Lawn Terrace:
   3. Size: 18"x24"x2"thick, modular size
   5. Type: Virginia Mist, Jet Mist or equivalent.
B. **Dimensional Cut Granite Pavers: Type 1B**
   1. Manufactured by North Carolina Granite, Inc, or equal.
   2. Use: Lawn Terrace trim along the skylight:
   3. Size: 8"x24"x2" thick, modular size
   5. Type: Virginia Mist, Jet Mist or equivalent.

C. **Dimensional Cut Granite Pavers: Type 2**
   1. Manufactured by Structural Stone, Inc, or equal.
   2. Use: Lawn Terrace:
   3. Size: Random sizes, 2" thick.
   5. Type: Southern Yellow Waterjet, or equivalent

2.4 **AGGREGATE SETTING-BED MATERIALS [C]**

A. In addition to meeting more stringent specifications that may be found in various sections of the project manual, all stone or aggregate used for, or as a component of, Structural fill shall meet the following requirements. Structural fill is defined as all fill placed under and around foundations, floor slabs, utilities, sidewalks and pavements.
   1. Be provided only from PENNDOT approved sources.
   2. Be quarried from the following formations in the Central Pennsylvania region:
      a. **Limestone**
         1) Nealmont Formation (Rodman and Centre Hall members)
         2) Linden Hall Formation (Valentine, Valley View, and Stover Members)
         3) Snyder Formation
         4) Hatter Formation
      b. **Dolostone**
         1) Bellefonte Formation (tea Creek and Coffee Run members)
         2) Nittany Formation
      c. **Mixed Limestone and Dolostone**
         1) Axemann Formation
   3. The selected aggregate material shall meet PENNDOT Specifications and these additional restrictions shall apply:
      a. Contain less than 0.5% pyrite (i.e.0.3% S)
      b. Contain less than 1% deleterious materials
      c. Limit the sulfur content to 0.1% if it is in the form of framboidal pyrite in a carbonaceous shale or whisker pyrite veins
      d. Contain less than 15% thin, elongate, or platy pieces.

B. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying with ASTM D 2940, subbase material and requirements in Division 2 Section "Earthwork" for subbase material.

C. Sand for Leveling Courses 1" or less: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.

D. Stone Screenings for Leveling Courses greater than 1": Sound stone screenings complying with ASTM D 448 for Size No. 10.

E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.

F. Drainage Geotextile: (If Required), Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater
than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
3. Permittivity: 0.5 per second, minimum; ASTM D 4491.
4. UV Stability: 50 percent after 500 hours’ exposure; ASTM D 4355.

G. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

2.5 MORTAR SETTING-BED MATERIALS

A. Laticrete 220, Medium bed or Laticrete 226 Thick bed floor and wall, sand base mortar or approved equal.

B. Laticrete 3701 latex mortar Admix for use with 220 or 226 Laticrete materials, or approved equal.

C. Grout: Laticrete SpectraLock PRO grout, or approved equal meeting ANSI A118.3. Grout color to be determined.

2.6 EDGING

A. Stainless Steel 2-1/2"x 2-1/2"x1/16"thick angle. Provide bolt holes for fasteners at a maximum spacing of 18” o.c.

2.7 FOUNTAIN GRATING

A. McNichols Molded Fiberglass from polyester resin mix
   1. Molded Square Pattern, SPF Polyester
   2. Type, MS S-150
   3. 1-1/2” height,
   4. 3'-0” x 3'-0” square
   5. Color Dark Gray
   6. Fit to concrete fountain reservoir structure
   7. Order from Micnichols.com, or 1-800-237-3820
   8. Or Equal.

2.8 GRATE SUPPORTS

A. Westile Screwjack adjustable pedestal supports.
   1. Model B4 with C4 to support Fiberglass fountain grating
   2. Meets ASTM D746 and D1525
   3. Westile, Inc Littleton, CO 800-433-8453
   4. Or Equal

2.9 JOINT SEALANTS

A. See Section 07 9200 for approved exterior joint sealants.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

   1. Proceed with installation only after unsatisfactory conditions have been corrected.

   2. Where pavers are to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations. Examine areas where waterproofing system is turned up or flashed against vertical surfaces and horizontal waterproofing. Proceed with installation only after protection is in place.

3.2 CONCRETE BASE AND SETTING BED AT GARDEN

A. Install concrete base as per Section 03 3000. Extend the slab 3” beyond the pavers to include the paver edge restraint.

B. Clean concrete substrates to remove dirt, dust, debris, and loose particles.

C. For pavers set on sand setting beds, paving contractor shall verify that the 3” diameter slab through drains have been installed and are functioning. If these are not installed or there is a low spot or depression that is not draining, then contractor shall core drill the slab with additional through drains. Backfill each with clean 3/4” crushed aggregate stone.

D. Lay the sand setting bed and screed to level. The stainless steel edging may be installed along one side of the paver area to aid in installation. Maintain level and straight-line courses.

3.3 STAINLESS STEEL EDGE RESTRAINTS

A. Provide edge restraints as indicated.

   1. Install Stainless Steel edge restraints into concrete base. Depending on locations and applications, angles may be bolted to either the inside or outside of the pavers.

   2. Cut the base angle to allow the edging to curve in the configuration and dimensions shown on the Lawn Terrace pavers.

   3. Edging must contain a minimum of ½ the dimensional edge height of the paver. Shim as required maintaining a continuous edge along the face of the pavers.

3.4 MORTAR BED APPLICATIONS

A. Place mortar setting bed where indicated for granite paving installations. Coordinate with stonewall contractor for setting pavings around wall dimensional stone. If wall stone is set prior to pavers adjust stone so that there will be adequate depth for mortar setting bed and paver.
B. Screed setting bed to a nominal depth of 3/4 inch. Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated.

C. Use approved latex mortar material for the paver setting bed. Mix and apply according to manufacturers instructions. Do not mix more than can be set prior to the mortar compound setting up.

3.5 GRANITE PAVER INSTALLATION

A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

D. Granite Stone Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.

E. Install granite pavers with 3/8” joints typical on 3/4” latex mortar setting bed. After pavers have set and final patterns approved, tool joints with mortar to within 1” of paver surface.

F. Tolerances: Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.

G. Install backer rod and approved sealant along all paver joints. Install as per manufactures recommendation. Protect sealant from airborne debris and allow to thoroughly dry (48 hours) before allow any traffic over pavers.

3.6 BRICK PAVER INSTALLATION

A. Prior to brick paver installation, verify that the fountain basin and mechanical systems have been installed. Verify grades and slopes for conformance with the plans.

B. Install screw jacks and fiberglass grating; verify that grating is slightly lower than the final brick grade of the garden. This is to allow the low point of the paving to be at the opening to the fountain nozzle. Note: bricks laid on grating are open joints, with no sand.

C. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.

D. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

E. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
F. Brick Joint Patterns: Shall be Running bond, with cross bond with Stretcher and Header courses, as shown on detail paving plans.

G. Tolerances: Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.

H. Fill and sand sweep brick joints with fine masonry sand ASTM C144. Repeat as required. Do not fill open joints over the fountain reservoir basin.

3.7 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point up joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

END OF SECTION 32 1400
SECTION 32 16 13.16 - CAST-IN-PLACE CONCRETE CURBS

PART 1 - GENERAL

1.1 SUMMARY

A. The work specified in this Section consists of furnishing and installing concrete curbs.

B. Related Sections:
   1. Section 31 20 00: Earth Moving.
   2. Section 32 10 00: Paving and Surfacing.
   3. Section 03 30 53: Miscellaneous Cast-In-Place Concrete.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
   2. ASTM D 1190, Specification for Concrete Joint Sealer, Hot-Poured Elastic Type.

B. American Association of State Highway and Transportation Officials (AASHTO):
   1. AASHTO M43, Standard Size of Coarse Aggregate for Highway Construction.

1.3 SUBMITTALS

A. Submit the following:
   2. Mix design for each change of ingredients or ingredient sources, including admixtures.
   3. Certificates of Compliance to specifications of materials provided as work of this Section.

PART 2 - PRODUCTS

2.1 FORMS

A. Steel forms:
   1. Approved flexible forms of steel or wood may be used for construction of circular curb where radius is 200 feet or less.

B. Forming:
   1. Use acceptable metal forms, except on sharp curves, and short tangent sections, where wood forms may be used if acceptable to the Contracting Officer.
   2. Forms shall extend full depth of the concrete.
2.2 MATERIALS

A. Concrete: Concrete conforming to requirements of Section 03 30 53: Miscellaneous Cast-in-Place Concrete except use No. 8 coarse aggregate, conforming to AASHTO M43, for concrete placed by extrusion method.
   1. Maximum Slump: 3 inches. For curbs placed by extrusion, maximum slump: 1 1/2 inches.
   2. Class A, Compressive strength 3000 psi at 28 days minimum.

B. Preformed Expansion Joint Filler:
   1. Fiber Type, ASTM D 1751.

C. Joint Sealer:
   1. Hot-applied: Rubberized joint sealing material, ASTM D 1190 or ASTM D 3405.
   2. Cold-applied: Elastomeric type, ASTM C 920.

PART 3 - EXECUTION

3.1 PREPARATORY WORK

A. Excavation: Excavate to the required depth, then compact the material upon which the curb is to be constructed to a firm, even surface.

B. Forms
   1. Erect forms true to line and grade.
   2. Secure forms in-place with iron stakes spaced on not more than four-foot centers.
   3. Indicate line and grade of curb tops by an offset guideline for extrusion placement.

3.2 CONSTRUCTION

A. Placing Concrete:
   1. Cast-In-Place: Conform to requirements of Section 03 30 53: Miscellaneous Cast-in-Place Concrete except place the concrete in the forms in layers not exceeding 5 inches in depth when spading, or layers not exceeding 15 inches in depth when using a vibrator to eliminate voids.
   2. By extruding machine (Where approved by the Contracting Officer):
      a. Uniformly feed the concrete to the machine so that concrete maintains the shape of the section without slumping after extrusion.
      b. Voids or honeycombs on the surface of the finished curb will not be allowed. Apply any additional surface finishing required immediately after extrusion.

B. Joints: Construct joints as follows:
   1. Expansion Joints:
      a. Space expansion joints at 30’ maximum or to match the adjoining sidewalk.
      b. Place 1/2 inch preformed expansion joint filler at expansion joints at ends of curb returns, and at junctures with structures. Place filler in single piece conforming to curb cross-section and depressed 1/2 inch below finished surface.
      c. Where curb is constructed in conjunction with adjacent sidewalk, the expansion joint in the curb and sidewalk shall coincide.
   2. Contraction Joints:
      a. For curb not constructed integrally with new base or pavement, form or saw contraction joint 3/16 inch wide, to a depth of 1/5 of the curb height at 10 foot
intervals. Saw as soon as possible after the concrete has set sufficiently to preclude raveling during the sawing.

b. Fill joint with hot-applied joint sealer.

3. Tool the edges of all joints adjacent to expansion filler to a 1/4 inch radius, leaving all joints free of mortar and concrete. Leave the joint filler exposed for the full length of the joint with clean and true edges.

C. Removal of Forms: Do not remove forms until such time that it will not be detrimental to the concrete. Correct irregular faces by rubbing with a carborundum stone.

D. Finishing:
1. Finish top edge of face to a one inch radius.
2. Trowel curb faces smooth either to a depth of not less than two inches below top of pavement or to the flow line of integral curb and gutter. Hand finish the face of curb with a steel trowel.
3. Provide a final fine brush finish to the top and face of curb with brush strokes parallel to the line of the curb.
4. Allow no coarse aggregate to show on the finished curb surface.

E. Curing: Conform to requirement of Section 03 30 53: Miscellaneous Cast-in-Place Concrete, except that liquid membrane curing compound shall not be used on curb when temperature tends to go lower than 40 degrees F within 24 hours after application.

F. Sealing Joints:
1. Seal all expansion joints, all joints between curb and vehicular pavements, and all joints between gutters and vehicular pavements to within 1/8 inch of the surface. (Do not seal other joints unless otherwise indicated or directed by the Contracting Officer.
2. Seal joints with (poured) joint sealer in conformance with the manufacturer's recommendations.

G. Backfilling:
1. As soon as possible after the removal of forms, and finishing as specified herein, backfill the voids in front and back of the curb using acceptable embankment material as specified in Section 31 20 00: Earth Moving.
2. Complete embankments in back of raised curb, as indicated, and as specified in Section 31 20 00: Earth Moving, except carefully compact the embankment by means of mechanical tampers, or rollers, if permitted, not exceeding 8 tons.
3. Where curbs are constructed in existing paved areas, all backfill between curb face and pavement shall be made with bituminous concrete base course material, thoroughly compacted in place in accordance with Section 32 10 00: Paving and Surfacing.

END OF SECTION 32 16 13.16
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SECTION 32 84 00 - PLANTING IRRIGATION [C]

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Integrated Rainwater storage tank and pump system:
      a. In-tank submersible pump with associated prefabricated, self-contained, VFD controls and electric panels, including pre-filter units.
   2. Irrigation Controller.
   3. Low Voltage Control Wiring.
   4. Sprinkler heads.
   5. Pipe and Fittings.
   6. Valves, including: Automatic, Manual, Quick-Coupling, Combination Air-Vent/Vacuum-Relief, and Drain.
   7. Sleevings: Soil-to-soil and Building wall, interior-to-soil.
   8. Coordination and interface with work of other involved trades, including: Landscaping, Plumbing, Electrical, Cast in Place Concrete, Waterproofing, and Site Drainage.
   9. Commissioning - Check, Test, Start-up, Adjust, and Demonstrate system.
   10. Other appurtenances necessary to provide a complete, operable, automated irrigation system sourced from cistern-stored rainwater with Domestic Water back-up.
   11. Close-Out Items, including: Record Drawings, Maintenance & Operation Manuals, and instruction of Owner Personnel.
   12. Warranties.

B. Related work:
   1. Primary Electrical service from source to Pumpstation Control Panel in Storage Room, and from Control Panel to submersible pump and other equipment in tank.
   2. Power to Irrigation System Controller – 120 Vac.
   3. Combined Rainleader connection to inlet of initial flush assemblies and “dirty water” discharge piping to site Storm.
   4. Tank overflow piping to site Storm.

C. Related Divisions include the following:
   1. Remainder of Division 32 – EXTERIOR IMPROVEMENTS.
   2. Division 03 – CONCRETE.
   3. Division 07 – THERMAL AND MOISTURE PROTECTION.
   4. Division 22 – PLUMBING.
   5. Division 26 – ELECTRICAL.
   6. Division 31 – EARTHWORK.
   7. Division 33 – UTILITIES.
1.3 SUBMITTALS

A. Submit Product Data/Catalog cuts for the following:
   1. From a single source:
      a. Fiberglass Tank (cistern), including features and options.
      b. Pump Station and Control Panel, including wiring schematics.
      c. Rainwater filter units.
   2. Irrigation Control system with related equipment (decoders, moisture sensor, etc.).
   4. Rain Sensor.
   5. Remote Control Zone Valve (RCV).
   6. Combination Air-Vent/Vacuum-Relief Valve.
   7. Quick-Coupling Valve.
   10. Communication Cable and Low Voltage Control Wires.
   11. Wire Splice Waterproofing materials and methods.
   13. PVC Pipe and Fittings.
   15. Solvent Cement and Primer.
   17. Valve Tags and Valve Tag Schedule for Interior Make-up water Valves.

B. Qualification Data: For firms and persons specified in “Quality Assurance” paragraph below to demonstrate capabilities and experience: Include with Bid, a list of three (3) completed projects with project names and location, names and phone numbers of Owners and system Operators.

C. Hydrostatic Mainline Pressure Test.

D. Record Documents (“AS-BUILTS”) and Maintenance & Operating Manuals. See paragraph 1.7, below.

1.4 QUALITY ASSURANCE

A. Visit site prior to formulating Bid.

B. Installer Qualifications: Irrigation Sub-contractor must be certified as a Certified Irrigation Contractor (CIC) and for Commissioning operations, must be a Certified Landscape Irrigation Auditor (CLIA), certified by the Irrigation Association (IA), Fairfax, VA.

C. Ensure experienced, competent, English-speaking Foreman is on-site at all times when irrigation work is in progress. In addition, Foreman must be fluent in dominant language of crew.

D. Applicable requirements of accepted Standards and Codes, in effect at Date of Issue of Bid Documents, apply to Work of this Section, including:
   1. American Society for Testing and Materials (ASTM)
   2. American Water Works Association (AWWA)
   3. Unified Plumbing Code (UPC)
   4. National Electrical Code (NEC)
   5. National Sanitary Foundation (NSF)
   6. American Society of Irrigation Consultants (ASIC)
   7. The Irrigation Association (IA)
E. In addition to meeting more stringent specifications that may be found in various sections of the project manual, all stone or aggregate used for, or as a component of, Structural fill shall meet the following requirements. Structural fill is defined as all fill placed under and around foundations, floor slabs, utilities, sidewalks and pavements.
1. Be provided only from PENNDOT approved sources.
2. Be quarried from the following formations in the Central Pennsylvania region:
   a. Limestone
      1) Nealmont Formation (Rodman and Centre Hall members)
      2) Linden Hall Formation (Valentine, Valley View, and Stover Members)
      3) Snyder Formation
      4) Hatter Formation
   b. Dolostone
      1) Bellefonte Formation (tea Creek and Coffee Run members)
      2) Nittany Formation
   c. Mixed Limestone and Dolostone
      1) Axemann Formation
3. The selected aggregate material shall meet PENNDOT Specifications and these additional restrictions shall apply:
   a. Contain less than 0.5% pyrite (i.e.0.3% S)
   b. Contain less than 1% deleterious materials
   c. Limit the sulfur content to 0.1% if it is in the form of framboidal pyrite in a carbonaceous shale or whisker pyrite veins
   d. Contain less than 15% thin, elongate, or platy pieces.

1.5 TESTS

A. Perform tests in presence of designated Owner’s Representative.

B. See applicable paragraphs under Part 3 – Execution, below.

1.6 DELIVERY, HANDLING, AND STORAGE

A. Pack, ship, deliver, receive, handle, store, and prepare and install materials and equipment in accordance with Manufacturers’ recommendations and in such manner as to protect from damage due to weather, vandalism, thievery, job-site activities, or other cause.

B. Coordinate on-site materials storage with General Superintendent.

1.7 MAINTENANCE & OPERATION INSTRUCTIONS

A. Not later than 45 days following completion of work and prior to application for acceptance and final payment, submit to Landscape Architect:
   a) Two (2) three-ring binders titled MAINTENANCE & OPERATING INSTRUCTIONS FOR PSU HENDERSON BIOBEHAVIORAL HEALTH BUILDING IRRIGATION SYSTEM PUMPING PLANT, for Manufacturer’s materials relating to the tank and pumpstation; and, b) Two (2) three-ring binders titled MAINTENANCE & OPERATING INSTRUCTIONS FOR PSU HENDERSON BIOBEHAVIORAL HEALTH BUILDING IRRIGATION SYSTEM, for information relating to general system components – control system, valves, etc. – maintenance and troubleshooting.

B. Include the following in b): One (1) half-scale black-line print of Record Document Drawings (“AS-BUILTS”); One (1) set of APPROVED irrigation submittals listed above; and, description of procedures to be followed for Winterization and Spring Start-up of system.
C. Perform first two (2) years' Winterization and Spring Start-up operations in presence of Owner’s designated representative.

1.8 EXTRA MATERIALS

A. Provide at Closeout:
   1. Two (2) 30” long by 3/8” diameter formed and welded “devil’s fork” valve wrenches by Weather*matic or equal, for cross-handle and RCV flow control handles.
   3. Two (2) QCV Keys with Swivel-Hose ells.
   4. Two (2) Controller Door Keys.

1.9 WARRANTIES

A. For Pre-fabricated Pumpstation: One (1) year from date of Start-up or eighteen (18) months from date of shipment, whichever is the shorter.

B. For general irrigation system parts and labor – Heads, valves, piping, wiring, etc.: Two (2) years from date of Start-up.

C. Control System: Provide five (5) year warranty in accordance with Manufacturer’s Instructions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide new materials conforming to applicable Standards and in accordance with APPROVED Submittals.

B. Provide most recent model of named Manufacturers’ products. Application for substitution(s) may be considered based on equivalency of performance, features, and options. Owner’s Representative will be sole arbiter as to equivalency of products.

2.2 SYSTEM EQUIPMENT AND MATERIALS

A. Tank, Pump, Filtration equipment, and Pump Controls: All components from single supplier/manufacturer. See Drawing LI 2.2 for notes and Specifications: SkyHarvester tank and pump assembly, including controls and accessories, manufactured by WaterTronics, Inc., Hedland, WI, including:
   1. Tank with pump, hold-down straps, access Manway, less manhole ring and cover at finish grade.
   2. Initial Filtration Units.
   3. Submersible Pump in tank and Control Panel in Storage Rm.
   4. Domestic Water Make-up Valve assembly.

B. Final Filter: Netafim 1½", Model DF150-120, 120 mesh disc filter.

C. Control System: Baseline, BaseStation 3200, wall-mount model, remote-ready, manufactured by BASELINE, LLC, Traverse City, MI, with the following features/accessories:
   1. byline (two-wire) path - #14AWG.
   2. biCoders.
   3. Soil Moisture Sensor – BL-5315, 18”L.
   4. Water Budget – 25% to 200% by program.
5. Up to 10 programs; up to 8 start times per program.
7. Surge protection.

D. Remote Control Device: TRC Commander System with Permanent Receiver Card and Transmitter, manufactured by TRC Irrigation Remotes, Kirkland WA. Provide Phantom Antenna Valve Box.

E. Rain Sensor: Model RDS-CEx manufactured by Rain Bird Corporation, Tucson, AZ.

F. Communication Cable and Low Voltage Wire:
2. From biCoders to RCV solenoid: Single conductor, #14AWG, Type PE, UL-labeled Cable, RED and WHITE.
3. Rain Sensor: BROWN.
4. Splice waterproofing: Gel-filled insulator tube, DBY-6 or DBR-6, 600V rated, manufactured by 3M Company, Austin, TX.

G. Remote Control Valve (RCV): PESB Series, Manufactured by Rain Bird Corporation, Tucson, AZ.


I. Quick-Coupling Valves: Model 33-DNP with 33-DK Key, and SH-0 Swivel Hose Ell, manufactured by Rain Bird Corporation, Tucson, AZ.

J. Combination Air-Vent/Vacuum-Relief Valve: Crispin, Model AL10, manufactured by Multiplex Corp., Berwick, PA.

K. Valve and Splice Boxes:
1. In turf areas: Polyconcrete box and lid, “H-20” Series with 1¼” cover, manufactured by Carson Industries, Glendora, CA. Provide drill-holes.
2. In planted areas: HDPE, VB Series, manufactured by Rain Bird Corp., Tucson, AZ, or Specification Grade, manufactured by Carson Industries, black, with black, bolt-down lids.

L. PVC Pipe and Fittings: Manufactured by Cresline Plastic Pipe Company, Inc., Evansville, IN, Charlotte Pipe and Foundry, JM, or Silverline.
1. Interior piping: Materials and methods in accordance with Division 22 – Plumbing.
2. Exterior piping (below-grade) and fittings: Sch-40 PVC, ASTM D 1784, ASTM D 1785, fittings, SCH-40 PVC, ASTM D 1784, ASTM D2466, solvent-weld, or threaded to match connected equipment.

M. Wall sleeves: Link-Seal, Model “C”, with water-stop flange, manufactured by Pipeline Seal and Insulator, Inc.

N. Manual Isolation Ball Valves: PVC, Safety-block, full bore, True Union, minimum 150 PSI, by Spears Manufacturing Co., Sylmar, CA, or equal by Nibco or Dura.
O. PVC Primer and Solvent Cement: Manufactured by NIBCO/Chemtrol, Christy's, Hercules, Weld-On, or equal, NSF and UPC labeled.
   1. Primer: Purple in color, F 656.
   2. Solvent Cement: Clear, Blue, or Gray in color, ASTM D 2564.

P. Trench-Marking Tape: Two-inch wide, detectable, BLUE or GREEN, marked “Buried Water Line” or other appropriate wording, manufactured by Christy’s or Seaton.

Q. Valve Tags: 1½” diameter Brass or laminated plastic, with “IRR #XX” lacquer-filled or stamped, manufactured by Christy’s or Seaton.

PART 3 - EXECUTION

3.1 GENERAL


B. Install equipment and materials in accordance with Manufacturers’ recommendations unless otherwise indicated/directed.

C. Make field measurements for Work noting relationship of irrigation Work to existing and new work of other trades. Coordinate with other trades (paving, landscaping, electrical, mechanical, and other site trades). Lay out project essentially as indicated on Irrigation Plans and Details, making adjustments for variations in planting bed lines, pavement and building conditions, critical tree root-zone areas, and interference with new and existing utilities. Piping layouts indicated in the Documents are diagrammatic to the extent that no attempt has been made to indicate all potentially-required offsets and fittings.

D. Stake tank and filter units locations, routing of mainlines and wiring, lateral piping, sprinkler heads, air-vent valve, and valve boxes. Review intended routes with Owner Representative. Existing utilities, critical tree root zone areas, and other conditions may require re-routing of irrigation piping.

E. Complete project in stages. Once begun, complete section without unnecessary delay. Do not leave project unmanned unless progress delayed by job conditions or weather. Owner representative and irrigation foreman will agree in determining justification for leaving project unmanned. If to be left unmanned for period exceeding 18 hours, backfill and tamp trenches. Broom and hose-clean pavements.

F. Conduct installation so as to protect new and existing landscaping, site electric, drainage systems, paving, structures, walls, footings and foundations, waterproofing, and other work and utilities, from damage. Piping installed overstructure is to be hand-placed prior to placement of select fill, or hand trenches if installed following fill placement. No mechanical trenching overstructure will be permitted. No vibratory plow installation will be allowed for on-grade piping installation. Report damage to work of other trade(s) to Owner Representative immediately. Make or arrange repairs to satisfaction of Owner Representative.

G. See Drawings LI-2.1 and LI-2.2 for Details and notes.
3.2 EXCAVATION, BACKFILL, AND PIPE INSTALLATION

A. Locate, identify, and mark existing below-grade utilities including site-lighting electrical wire paths. Contact local utility location service provider three (3) days prior to commencing excavation work. Review Site Utility Drawings for existing and new utilities. On-site utilities not located by utility locator are to be located by Contractor with assistance of Owner Representative.

B. Determine in field locations of pavement crossings. Ensure sleeving is placed as construction progresses.

C. On-grade piping: Excavate with minimum-width trenched chain for installation of piping and wiring. Excavate to a depth of within +1" of pipe invert, provided a suitable base, i.e., no sharp edges or rocks over 1" in diameter, is available. If not, excavate to 1” below invert and provide sand or clean fill base on which to lay pipe. Provide Manual Angle drain valve at low end of mainline vehicular pavement crossings. Manually “pot-hole” (dig test pit) at existing utilities to determine actual location and depth.
   1. Over-structure piping: Employ no mechanical trenching. Ensure no damage to waterproofing system. Hand-place piping on waterproofing mat prior to placement of select fill, or hand-trench if following fill placement.

D. Cut plastic pipe square and true with hand saw or pipe-cutting tool. Remove burrs at cut ends. Make solvent-weld joints in accordance with manufacturer’s recommendations relating to preparation, temperature, humidity, and cure-time. Make certain not to apply an excess of primer or solvent, and wipe excess solvent from each made connection. Allow connections to set as recommended before assembly is moved or pressure is applied to system.

E. Ensure no stress to piping at fitting shoulders at interface with trench bottom.

F. Valve wiring: Lay in same trench, and at same invert, as mainline. See paragraph below.

G. Backfilling: Initial 6”: Exclude foreign matter, frozen soil, and rock larger than 1/2” diameter. Carefully place fill material around pipe and wire filling voids, and hand-tamp. Remainder of backfill: Lay-up in 6” lifts and mechanically tamp to match compaction of surrounding undisturbed areas. Install trench-marking tape at 6” to 8” depth. Top 6”: Topsoil quality and without foreign material, frozen soil, and unsuitable trenching spoils. Record pipe and wire locations daily on field-kept “AS-BUILTS”.

3.3 TANK AND ASSOCIATED EQUIPMENT INSTALLATION

A. See Drawing LI-2.2, Plumbing, and Civil Drawings. Coordinate installation with General Superintendent. Ensure equipment and wiring is installed in accordance with Manufacturer’s recommendations and APPROVED submittals.

B. Control Panel: Form, pour, level, and finish concrete housekeeping pad in accordance with Division 3 – Concrete, in Storage Rm.
   1. Mount, wire, ground, and test in accordance with Manufacturer’s instructions.

3.4 VALVE INSTALLATION

A. Automatic valve (RCV): Set in Standard size valve box with adjusting handle and solenoid vertical-up. Provide line-size isolation ball valve at inlet. Wiring shall be of sufficient length to permit solenoid to be brought to surface. Coil extra wire neatly in valve box. Provide filter fabric
and 4” to 6” washed gravel under each valve box. Bring gravel up to pipe invert. Do not cover components with gravel.

1. Set, connect, wire, and ground decoder in accordance with Manufacturer’s Recommendations.

B. Quick-Coupling Valves: Install on prefabricated three-ell SCH-80 swing joint in 10” diameter valve box set to finish grade. Stake with re-bar and stainless steel hose clamps

3.5 SPRINKLER INSTALLATION

A. Set to finish grade. Maintain 3” to 4” clearance from side of sprinkler cap to nearest hardscape. Reset sprinklers to finish grade during warranty period if necessary. See flushing requirements below.

B. Reset sprinklers to finish grade during warranty period if necessary.

C. Swing pipe: 1/2” swing pipe with barbed fittings. Maximum length-14”; minimum length-10”.

D. Rigid risers above grade not permitted.

3.6 CONTROLLER INSTALLATION

A. Wall-mount generally where indicated. Mounting height: 4’-6” above finish floor (AFF) to bottom of cabinet. Determine final location in Storage Rm. in field.

B. Above-ground wire and wire to soil: Install in conduit conforming to requirements of Division 26 – Electrical. Provide Link-Seal waterproof wall sleeves at exterior walls.

C. Wire, ground, and test in accordance with Manufacturer’s recommendations.

D. Moisture Sensor (bisensor): Install, check, and adjust in accordance with Manufacturer’s Recommendations.

3.7 RAIN SENSOR INSTALLATION

A. Locate generally as indicated on outside wall.

B. Install, wire, ground, and test in accordance with Manufacturer’s recommendations.

C. Exposed/above-grade wiring: Install in rigid galvanized conduit.

3.8 WIRE INSTALLATION

A. Power wiring. Wiring greater than 30 Vac: Install in conduits in accordance Division 26 - Electrical.

B. Low voltage control wiring: Install in conduits within Building and as detailed.

1. Two-wire path below-grade: Install adjacent to, and at same invert as, mainline piping using open-trench method. Provide additional slack at changes of direction. Wiring shall at no time be installed taut. Provide moisture-proof junction-box as wiring exits Building and continue wire as direct-bury.

3.9 START-UP AND ADJUST OPERATIONS – PIPING AND SPRINKLERS
A. To be performed by a CLIA.

B. Flushing: After piping, valves and sprinkler bodies are in place and connected, but prior to installation of sprinkler internals, flush piping under full head of water until discharge runs clear and clean. Install internals and proceed to adjust system.

C. Leak Test: Flush, cap, and test mainlines for leaks: Test Pressure: 150 PSI; Time: 2 hrs. Maximum pressure drop: 5 PSI. Repair leaks and re-test until satisfactory results are obtained. Provide pump and necessary equipment to accomplish testing. Mainlines may be tested in sections at Contractor option. Laterals: Test at system normal operating pressure. Backfilling may be done prior to testing.

D. Adjustment: Adjust sprinkler heads for optimum performance and to prevent over-spray onto walks, pavement, and structures. Adjustments may include changes in nozzle sizes, and/or degrees of arc, and/or distance of throw. Overthrow onto walks and buildings, is not permissible. Set/adjust sprinkler heads perpendicular to finish grade unless shown or directed otherwise.

E. Coverage Test: Perform coverage test in presence of Owner Representative. Coordinate coverage test/walk-through with Owner Representative. Representative will determine if water coverage is complete and adequate. Re-adjust heads or head locations as necessary to or directed to achieve proper coverage.
3.10 **START-UP AND ADJUST OPERATIONS – CONTROL SYSTEM**

A. To be performed by a CLIA.

B. Control system shall be programmed and checked-out in accordance with manufacturer’s recommendations. See also requirements of Para. 1.7, MAINTENANCE AND OPERATION INSTRUCTIONS.

3.11 **START-UP AND ADJUST OPERATIONS – PUMPSTATION**

A. To be performed by Factory-trained technician in accordance with Manufacturer’s Recommendations and Instructions.

B. Do not operate pump prior to start-up operations.

3.12 **CLEAN UP**

A. Following completion of installation work, remove leftover materials and equipment from site and dispose of in safe and legal manner. Re-tamp work areas, replace sod and mulch and broom-clean and hose-off pavements.

B. Leave site in at least as neat and clean condition as when irrigation installation was begun.

3.13 **CLOSE-OUT**

A. See DIVISION 01 - GENERAL REQUIREMENTS for additional requirements.

B. To be performed by a CLIA.

C. At completion of “walk-through” and instruction of OWNER personnel, and prior to application for final payment, ensure that following are in order:

1. Permits: Signed-off by appropriate parties.

2. Hydraulic test: Signed-off by Owner Representative.


4. Submit completed and signed Extended 5-year Equipment Warranty Application for Baseline control system within 30 days of Controller installation.

5. Record Documents (“AS-BUILTS”): Completed and included in M & O Manuals.

6. Maintenance & Operating Manuals: Assembled and delivered to Owner Representative.

END OF SECTION 32 84 00
SECTION 32 9100 - PLANTING SOILS

PART 1 – GENERAL

1.1 SUMMARY

A. The work in this section includes all labor, materials, and installation methods for:
   1. Adherence to PSU commitment to protecting its native soils, through Soil Protection Zones and measures after excavating and stockpiling soils.
   2. Assess salvaged stockpiled topsoil for use in planting mixes and backfills.
   3. Separating of salvaged topsoil that is found suitable for use and determining topsoil quantity.
   4. Furnishing approved topsoil from outside sources should existing salvaged topsoil not be of sufficient quantity to complete the project.
   5. Provide soils tests and data for evaluation and approvals of the soil mixes, topsoil, sand and organic materials.
   6. Restoration of compacted soils and preparation of existing subgrade to receive planting mixes and restoration of lawn areas, including the HUB Lawn that is disturbed or damaged by the work.

1.2 RELATED SECTIONS AND REFERENCES

A. Related Sections:
   1. Section 01 5639 – Temporary Tree and Plant Protection
   2. Section 31 1000 – Earthwork
   3. Section 32 8400 – Irrigation
   4. Section 32 9200 – Turf and Grasses
   5. Section 32 9300 – Exterior Plants
   6. Section 32 9500 - Vegetated Roof Assemblies
   7. Section 32 9510 – Lawn Terrace Roof Assembly

B. References:

   1. The following references and standards are used herein and shall mean:

      b. USDA: United States Department of Agriculture.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer product data and literature describing all products required by this section to the University Representative for approval. Provide initial submittal twelve weeks before the installation of Planting Mixes and Roof Assemblies for the Auditorium.

B. Material Certificates: Submit material certificates for all natural and bulk material indicating that the material meets the requirements of the specification to the University Representative for approval. Provide initial submittal twelve weeks before the installation of Planting Mixes.
C. Certification from an approved independent testing laboratory experienced in testing rubberized asphalt material, that the material meets the CGSB-37.50-M89 standard for rubberized asphalt membranes, including applicable ASTM procedures.

D. Certification showing full time quality control of production facilities responsible for the manufacture of the rubberized asphalt and that each batch of material is tested to insure conformance with the manufacturers published physical properties.

E. Certification showing that all components of the green roof assembly are being supplied and warranted by a single-source manufacturer

F. Certification that the roof membrane assembly is currently Class A listed with Underwriters Laboratories.

G. Documentation that the extruded polystyrene insulation if used is free from CFC's.

H. Provide product data on all components of the green roof assembly.

I. Samples: Submit samples of each product and material where required by the specification to the University Representative for approval. Label samples to indicate product, specification number, characteristics, and locations in the Work. Delivered materials shall closely match the samples.

1. Submit four (4) -1 gallon samples of all topsoil (salvaged and imported), coarse sand, and organics and one-gallon samples of planting mixes, and soil additive products in this section. The number of samples shall be as required for each material.

   a. Samples should be labeled to include the location of the source of the material.
   
   b. Samples of all topsoil, drainage fill, coarse sand, and planting mixes shall be submitted at the same time as the particle size and physical analysis of that material.
   
   c. Planting mixes shall be labeled as to the percentage of each component in the mix.
   
   d. Samples of all products and planting mix components shall be submitted twelve weeks before the installation of planting mixes. Planting mixes shall be submitted within two weeks following approval of the mix component.

2. Submit soil test analysis report for each sample of topsoil and planting mix from an approved soil-testing laboratory below.

   a. The soil testing laboratory shall be approved by the University Representative in advance if differs from the testing labs recommended below and shall have a minimum of 5 years experience with the test protocols of the United States Golf Association - Green Section.
   
   b. Provide a particle size analysis including the following gradient of mineral content:

   USDA Designation  Size in mm.
Gravel +2mm
Very Coarse Sand 1-2 mm
Coarse Sand 0.5 -1 mm
Medium Sand 0.25-0.5 mm
Fine Sand 0.1-0.25 mm
Very Fine Sand 0.05-0.1 mm
Silt 0.002-0.05 mm
Clay minus 0.002 mm

c. Provide a chemical analysis including the following:

1. pH and Buffer pH.
2. Percent organic content by oven dried weight.
3. Nutrient levels by parts per million including nitrogen, phosphorus, potassium magnesium, manganese, iron, zinc and calcium. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the planting mix for the plant material specified.
4. Soluble salt by electrical conductivity of a 1:2 soil water sample measured in Milliohm per cm.
5. Cation Exchange Capacity (CEC).

d. Provide a physical analysis of each planting mix to include the following test results to the University Representative for approval:

Water permeability with the sample compacted between 80% and 85% maximum proctor density utilizing proctor test (ASTM D 698-91).

Bulk density with sample compacted between 80% and 85% maximum proctor density utilizing proctor test (ASTM D 698-91).

e. All testing will be at the expense of the Contractor. The University Representative may request additional planting mix tests on different mix component ratios in order to attain results that more closely meet the mix requirements.

D. Submit the manufacturer's particle size analysis for all Coarse Sand to the University Representative for approval. Provide the manufacturer's Fines Modulus Index for each Coarse Sand source.

E. Submit the manufacturer’s particle size analysis, pH and certificate of length of composting period for all pine bark and other organic materials to the University Representative for approval.

F. Testing of soils and planting mixes shall be performed by:

CLC Labs
325 Venture Drive
Westerville, Ohio 43081
614 888 1663
or approved equal.

G. Water permeability and bulk density testing if required shall be performed by:
1.4 SOIL BULK DENSITY TESTING

A. Undertake all soil bulk density testing at the contractor's expense. All soil testing shall be undertaken by a soil testing service experienced in both bulk density and proctor density testing protocols.

B. Submit soil compaction testing service firm’s qualifications for approval.

1.5 SEQUENCING AND SCHEDULING

A. General: Prior to the start of Work, prepare a detailed schedule of the work for coordination with other trades. Schedule shall include sampling and laboratory turnaround time, including time for re-submittals if required to satisfy requirements of the specifications.

B. Schedule the installation of planting mixes after the area is no longer required for use by other trades and work.

C. Schedule all utility installations prior to beginning work in this section.

1.6 QUALITY ASSURANCE

A. Contractor is solely responsible for quality control of the Work.

B. The installer shall be a firm having at least 5 years of successful experience of a scope similar to that required for the Work, including the preparation, mixing and installation of custom planting mixes in urban locations and over building structures.

C. Comply with applicable requirements of the laws, codes, ordinances and regulations of federal, State and municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

D. Comply with all requirements for control of silt and sediment during soil installation work as indicated in the contract documents.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Weather: Do not mix, deliver or place soils in frozen, wet, or muddy conditions.

B. Protect soil and planting mix stockpiles from rain and washing that can separate fines and coarse material. Cover stockpiles with filter cloth at the end of each workday.

C. Protect planting mix stockpiles from contamination by chemicals, dust and debris that may be detrimental to plants or soil drainage.
1.8 SITE CONDITIONS

A. It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to report any circumstances that will negatively impact soil drainage. Do not proceed with work until unsatisfactory conditions have been corrected.

1.9 PROTECTION OF EXISTING UTILITIES

A. Prior to any work being performed the Contractor shall insure that all existing utilities within and surrounding the project site have been clearly marked in accordance with the Pennsylvania Underground Utility Line Protection Act 287 as amended by Act199.

B. Carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.

PART 2 – PRODUCTS

2.1 SALVAGED STOCKPILED TOPSOIL

A. Acceptable friable loamy soil that is reasonably free of subsoil, clay, brush, roots, weeds, other objectionable vegetation, stones, or other foreign material larger than 2 inches in any dimension, litter, and/or other material unsuitable or harmful to the growing of vegetation.

B. If conditions permit contractor shall remove and salvage as much Brown to grey/brown loam to clay loam organic soil prior to the start of construction and stockpiled at the site.

C. Soils encountered that contain quantities of orange/brown to orange clay soil shall be discarded and not used.

D. Quantities of usable material are not confirmed. The Contractor shall confirm the quantities of existing soil available at the site.

2.2 IMPORTED TOPSOIL

A. Shall have the same criteria as outlined above for Salvaged and Stockpiled Topsoil containing not less than 2.0% or more than 10% percent by weight organic matter. The soils obtained shall be obtained from a site where the soil quality has proven ability to grow crops. The pH value shall be between 6.0 and 7.0.
   1. The Contractor is responsible for the reconditioning of the area from which the topsoil is obtained, and in accordance with all Local, State, and Federal regulations.
   2. The contractor shall supply necessary documentation verifying that topsoil is free of contamination.

B. Soil Texture: Loam to Coarse Sandy loam with clay content between 15 and 20% and sand content between 45 and 60%.

C. Soil shall be lighting screened and shredded prior to mixing but shall retain some of the original soil structure with ped sizes (clods) not greater than 2” diameter.
E. Provide a minimum of 3 soil tests that represents the range of the soil types available at any one-source location.

F. Provide four (4) 1-gallon samples from each topsoil source with soil testing results. The sample shall be a mixture of the multiple samples taken throughout the source stockpile or field.

2.3 PINE BARK

A. Horticultural grade milled loblolly pine bark, size 0.1 mm - 15.0 mm. Pine bark shall be aged at least nine months and shall be screened. pH shall range between 4 and 5. Pine bark shall be Pro Base, as manufactured by Summit Inc., Wakefield, VA. Or approved equal.

B. Provide a one-gallon sample with manufacturer’s literature and material certification that the product meets the requirements.

2.4 COARSE SAND

A. Coarse concrete sand, ASTM C-33 Fine Aggregate, with a Fines Modulus Index of 2.8 and 3.2.

1. Coarse Sands shall be clean, sharp, natural sands free of limestone, shale and slate particles. Coarse Sand pH shall be lower than 7.0.

2. Provide the following particle size distribution:

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 inch (9.5mm)</td>
<td>100</td>
</tr>
<tr>
<td>No 4 (4.75mm)</td>
<td>95-100</td>
</tr>
<tr>
<td>No 8 (2.36mm)</td>
<td>80-100</td>
</tr>
<tr>
<td>No 16 (1.18mm)</td>
<td>50-85</td>
</tr>
<tr>
<td>No 30 (.60mm)</td>
<td>25-60</td>
</tr>
<tr>
<td>No 50 (.30mm)</td>
<td>10-30</td>
</tr>
<tr>
<td>No 100 (.15mm)</td>
<td>2-10</td>
</tr>
</tbody>
</table>

B. Provide two 1-gallon samples with manufacturer’s literature and material certification that the product meets the requirements.

2.5 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural limestone containing a minimum 80% calcium carbonate equivalent and as follows:

1. Class: Class T, with a minimum 99 percent passing through No. 8 (2.36-mm) sieve and a minimum of 75% passing through No. 60 (0.25-mm) sieve.

2. Class: Class O, with a minimum 95 percent passing through No. 8 (2.36-mm) sieve and a minimum of 55% passing through No. 60 (0.25-mm) sieve.

3. Provide Lime in the form of dolomitic limestone.

B. Sulfur: Granular, biodegradable, containing a minimum of 90% sulfur with a minimum 99% passing through No. 6 (3.35-mm) sieve and a minimum of 10% passing through No. 40 (0.425-mm) sieve.

C. Iron sulfate: Granulated ferrous sulfate containing a minimum of 20% iron and 10% sulfur.
D. Aluminum Sulfate: Commercial Grade, unadulterated.

E. Agricultural Gypsum: Finely ground, containing a minimum of 90% calcium sulfate.

F. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption.

2.5 ORGANIC MATTER

A. Organic blended material composted sufficiently to break down all woody fibers, seeds and leaf structures, free of toxic and non-organic matter. Source material shall be limited to the following:

1. Aerobically composted yard debris. Note compost made from primarily green yard waste shall not be acceptable.
2. Hardwood bark fines and organic material designed to produce compost high in fungal material.
3. Biosolids compost, or combination of the above.
5. Submit one-pound sample and supplier’s literature certifying STA compliance for approval.

B. Compost shall be a homogeneous material free of soil clods, lumps, roots, stones, and foreign material. The compost shall be screened such that a minimum of 90% passes US standard 0.25” sieve and no more than 20% passes a US Std. No. 10 sieve.

C. Provide a one-gallon sample with manufacturer’s literature and material certification that the product meets the requirements.

D. pH of 5.5 to 6.5.

E. Soluble Salts: less than 6.0 milliohms per cm when determined on saturation extract.

F. Organic Matter Content: 35% or greater, as determined by weight by ASTM D2974-87 Method C.

G. Carbon Nitrogen Ratio: less than 36:1

H. All compost testing shall be done in conformance with the U.S. Compost Council’s publication Test Methods for the Examination of Composting and Compost unless specified otherwise.

I. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.6 CHEMICAL ADDITIVES

A. Chemical materials designed to increase soil fertility. All material shall be delivered to the site in unopened containers and stored in a dry enclosed space suitable for the material and meeting all environmental regulations. Biological additives shall be protected from extreme cold and heat. All products shall be freshly manufactured and dated for the season in which the products are to be used.
1. Fertilizer for planting shall be organic fertilizer, derived from organic sources. Fertilizer selections shall be based on the recommendations of the soil tests. Submit manufacturers' product literature for approval.

2.7 GENERAL PLANTING AND LAWN MIX (Off Structure)

A. General planting mix shall be of 100% approved and tested salvaged soils or imported topsoil.

B. DO NOT overly mix or screen soil. Planting mix should contain individual soil peds (clods) averaging between 1-2 inches in diameter from the original soil structure. No clods are to be larger than 2 inches in diameter in any direction.

C. Adjust the final mix pH to 6.0-7.0.

D. Provide a one-gallon sample with soil test results as requested by the University Representative.

PART 3 – EXECUTION

3.1 SITE EXAMINATION

A. Protect of Existing Vegetation: All existing vegetation to remain shall be protected at all times in accordance with Section 01 3956 – Temporary Tree and Plant Protection.

B. Examine the grades and soil conditions for any circumstances that might be detrimental to soil drainage, including but not limited to: uneven subgrades and waterproofing that may hold or pond water; deposits of construction-related sediment, waste or soil contamination; storage of material or equipment; soil compaction or poor drainage. Confirm that all utility work and installation of planter or on structure drainage has been completed and tested. Examine the grading verifying all elevations. Confirm that all other work in the area of planting mix installation is completed. Confirm that subgrade conditions present positive flow to outfall or building edge conditions such that all planting areas will have positive subsurface drainage.

C. Notify the University Representative in writing of any unsatisfactory conditions.

3.2 COORDINATION WITH PROJECT WORK

A. The Contractor shall coordinate with all other work that may impact the completion of the work of this section. Do not place soils or mixes in any locations if they will be adversely compacted or disturbed from other trades work. Coordinate with the General Contractor to protect installed soils and planting mix from compaction by other trades.

B. Assure that all sediment control required by the project manual and as shown on the drawings is in place during the installation of planting mixes. Provide additional sediment control to retain planting mixes within the project limits as needed.

3.3 GRADE AND ELEVATION CONTROL
A. Provide grade and elevation control during installation of soils and planting mixes. Utilize grade stakes, surveying equipment and other means and methods to assure that grades and contours conform to the grades indicated on the drawings.

B. Maintain grade stakes until University Representative has viewed and approved the grades.

### 3.4 PLANTING MIX DESIGN AND TESTING

A. This specification is based on the assumption that the soils to be provided are natural and will vary in quality from location to location within the soil sources, and that mixing of soil will result in variety within the mix. The Contractor is expected to provide samples that represent the range of product quality to be provided and monitor for consistency during the mixing operations.

B. The Contractor shall submit mix specifications and proportions with test results for evaluation. Multiple rounds of testing and evaluations may be required before an approved planting mix can be determined. For each test mix, submit representative samples of the mix material along with the test results.

C. Note it is important for the contractor to understand that placing soils that are above 30% combined silt and clay particle content with inadequate or incorrect amounts of course sands additives may result in soils that once compacted will lock-up and not drain, thus not meeting the important soil permeability rates.

D. Schedule the planting mix testing phase such that all testing and mix design can be expected to be completed and approved a minimum of six weeks prior to the installation of planting mix on the Lawn Terrace. Contractor is cautioned not to wait until the progress of the project is almost complete and ready for planting mixes to begin his testing and mix approvals, as this will result in a delay of the mix placement and plantings.

### 3.5 PREPARATION OF SUBGRADE

A. Prior to commencing any soil placement and finish grading operations Contractor shall notify the University Representative allowing enough time for a thorough inspection of the Subgrade. Proceed with installation only after unsatisfactory conditions have been corrected and approved by the University Representative.

B. Prior to any work the Contractor shall have all utilities located by calling PA One-Call at (800) 242 1776.

C. Do not proceed with the installation of soils or planting mix, until all utility work in the area has been installed. Do not begin planting mix installation until all subsurface drainage, irrigation main lines, and lateral lines shown on the drawings are viewed and approved by University Representative.

D. Prior to grading, apply ROUND-UP or other approved herbicide as per the manufacturer’s directions if required to eliminate any existing weeds. Allow sufficient time for the herbicide to take effect.

E. Do not excavate beds in areas that may damage existing tree roots of mature trees.

F. If any areas are overly compacted or a hardpan, the subgrade shall first be rototilled or chisel plowed at least 12 inches deep to permit proper loosening, drainage, and preparation of the...
ground. The subgrade shall be loosened and graded by harrowing, discing, or dragging, as dictated by the conditions of the subgrade. See Section 32 9300 EXTERIOR PLANTS for additional instructions and perk tests to verify soil drainage in planting beds where required.

G. The entire subgrade shall then be raked and all stones over 1-1/2 inches, removed, as well as asphalt, concrete, aggregates, contaminated soils, brickbats, grade stakes, rubbish, and general debris, or any items deemed not conducive to good and normal plant growth and lawn establishment. Haul off-site and satisfactorily dispose of all unsuitable material.

H. Protect adjacent walls, walks and utilities from damage or staining by the soil or placement operations. Use 1/2-inch plywood and or plastic sheeting as directed to cover existing concrete, metal and masonry work and other items, and as directed by the University Representative during the progress of the work.
   1. Clean up any soil or dirt spilled on any paved surface, including at the end of each working day.
   2. The Contractor shall repair damages to the pavings or architectural finishes to the satisfaction of the University Representative.

I. Protect the prepared subgrade areas from traffic until the planting mix is installed. DO NOT allow the subgrade to become compacted. In the event that the roughened prepared areas become compacted, loosen the area again prior to installing soils or planting mixes.

### 3.6 GENERAL SOILS INSTALLATION

A. Begin installing approved soils and planting mixes by backfilling the beds and planting areas with the first lift by tilling or blending with existing loosened subgrade. Note soil pedds in the 1-2 inch range is acceptable and often aid in soil adhesion and drainage.

B. Soils and planting mixes shall be spread with approved equipment to a minimum depth of 6 inches to permit a 1-inch settlement. Place soils in 6-inch lifts compacting lightly to not more than 80-85% at the depths and elevations shown on the drawings.

C. Any surface irregularities shall be corrected to prevent the formation of low spots and pockets that would retain water.

D. Soils and planting mixes shall not be placed when the subgrade is frozen, excessively wet, or extremely dry, and no soils shall be handled when in a frozen or muddy condition.

E. Protect the tilled area from traffic until the planting mix is installed. DO NOT allow the subgrade to become compacted. In the event that the roughened area becomes compacted, loosen the area again prior to installing the planting mix.

### 3.7 APPLICATION OF ORGANICS AND CHEMICAL ADDITIVES

A. Contractor shall add up to 15% organic material in the top 24" of backfilled soils in planting beds.

B. Do not use fertilizers unless recommended by soils tests.
C. Following the installation of each planting mix, apply chemical additives in rates as recommended by the soil tests, and appropriate to the planting mix and specific plants to be installed.

D. Types, application rates and methods of application shall be approved by the University Representative prior to any applications.

E. Approximately one month after any application of chemical additives, re-sample and test the soil and apply additional applications if the soil tests indicate further chemical applications would be beneficial. Make sufficient tests to analyze each soil type and each plant association within that soil type.

3.8 RESTORATION OF DISTURBED SOIL – COMPACTED TOPSOILS

A. In any area of the site where existing lawn and planting areas have become compacted by construction activity, modify the soils bulk density to provide for suitable growing environments.

1. Compacted soil is defined as soil where vehicle traffic, storage, Contractor lay down or soil stockpiles have increased the soil bulk density in excess of:

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Bulk density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy loam</td>
<td>1.65 Mg/m³</td>
</tr>
<tr>
<td>Silt loam</td>
<td>1.55 Mg/m³</td>
</tr>
<tr>
<td>Clay loam</td>
<td>1.45 Mg/m³</td>
</tr>
</tbody>
</table>

B. Compaction shall be modified according to the following methods:

1. Renovated Lawns: Using a commercial grade power tiller, Toro Dingo Tiller model #22445 or a tiller with equivalent performance, till the compacted soil to a depth of 6”.
   Spread 3 inches of Pine Bark over the tilled area. Re-till the area to incorporate the Pine Bark into the compacted soil.

2. Proposed Shrub and tree beds outside of the tree protection area: Spread 6 inches of Pine Bark over the compacted area. Using a backhoe, dig through the Pine Bark to a depth of 24 inches below the original grade, lift the soil and turn the soil mass to break up the massive soil into clumps, and clods, allowing the Pine Bark to fall between the clumps and clods. Cover the resulting broken soil with 4 inches of organic matter and till into the top 6 inches of the soil. Fine grade and apply 2 inches of mulch.

3. Tree Preservation Areas: Should construction activities result in compacted soils Contractor may be required to perform vertical mulching or other soil aeration operations prior to mulching. These activities shall be recommended and monitored by the project Arborist. Vertical mulch the soil as follows. Using an air knife or similar pneumatic digging tool make holes in the soil 4 to 6 inches in diameter and 6 to 9 inches deep 24 inches on center. Fill the holes with a mixture of 50% 3/8-inch size expanded shale, Carolina Stalite or equal and 50% Pine Bark. Do not till if in the vicinity of existing mature trees.

4. In all areas, remove any soil or debris deposited on to the existing grades prior to implementing compaction reduction.

3.9 PROTECTION
A. Protect planting mix from compaction and contamination by dust, debris, and any toxic material harmful to plants or humans after placement. Any area, which becomes compacted, shall be tilled to a depth of 6". Any uneven or settled areas shall be filled and re-graded.

B. Phase the installation of the planting mix such that equipment does not have to travel over already installed planting mix.

3.10 CLEAN-UP

A. During installation, keep pavements clean and work area in an orderly condition.

B. Keep the site free of trash and debris at all times. Immediately dispose of wrappings or waste materials associated with products necessary for the completion of the work.

C. All trash shall be kept in a central collection container. Do not bury trash or debris in back-fill.

D. Once installation is complete, remove any excess soil from pavements, walls or other surfaces.

3.11 PROTECTION DURING CONSTRUCTION

A. The Contractor shall protect soil work and materials from damage due to landscape operations, operations by other Contractors or trespassers. Install 1/2-inch plywood mats over the soil wherever vehicles, equipment or foot traffic must enter the area. Maintain protection during installation until acceptance. Treat, repair or replace damaged planting mix installation work immediately.

B. Till compacted planting mix and replace planting mix that has become contaminated as determined by the University Representative. Planting mix shall be tilled or replaced by the Contractor at no expense to the Owner.

3.12 REPAIR OF SETTLED PLANTING MIX

A. At the end of twelve months after the date of substantial completion of the planting mix installation work, inspect the site and restore any areas where the grades have settled beyond the elevations shown on the drawings by an amount greater than 5% of the soil depth.

1. In shrub planting areas where the settlement is 3 inches or less, remove the mulch, top dress the area with the specified planting mix and re-mulch.

2. In all ground cover areas and shrub planting areas where the settlement is greater than 3 inches remove the mulch and plants, add the specified planting mix, re-plant and re-mulch.

3. In lawn areas, remove the sod. Till the surface and add the specified planting mix and re-sod using new sod.

END OF SECTION 32 9100
SECTION 32 9200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY
A. The work in this section includes all labor, materials, and installation methods necessary to establish the highest quality turf areas:
   1. Preparation of the site and placing soils as per Section 32 9100,
   2. Seeding lawn areas as indicated,
   3. Sod Lawn Terrace area as indicated,
   4. Lawn renovation in disturbed areas,
   5. Clean-up and protection of completed turf areas,
   6. Lawn maintenance until acceptance,
   7. Guarantee of all work, warranty of lawn areas.

1.2 RELATED SECTIONS
A. Section 32 9100, Planting Soils
B. Section 32 9300, Exterior Plants

1.3 DEFINITIONS
A. Initial Acceptance: Is defined as the event when the work is substantially completed and approved by the University Representative, and establishes the date for Lawn Maintenance period to commence.
B. Maintenance Turnover: Is the date of maintenance turn over to PSU for them to assume responsibility for the maintenance of the turf areas.
C. Finish Grade: Elevation of finished surface of planting soil for turf establishment.

1.4 REFERENCES
A. Chemical Soil Testing Procedures for the North Central Region (NCR-221)
C. U.S. Compost Council: Test Methods for the Examination of Compost and Composting

1.5 SUBMITTALS
A. Prior to the start of any seeding activity, the Contractor shall have the existing soil tested by an approved soil testing laboratory and the preparation of Soil Test Reports as per Section 32 9100 Planting Soils. Contractor shall furnish copies of the soil test results to the University Representative prior to any grading, seeding, or sodding.
B. The Contractor shall submit a Percolation Rate Test prior to commencing of and seed activity. This test is intended to determine the rate of percolation of the existing subgrade.

C. The Contractor will provide an inspection certification indicating the origin and health of seed and or sod material.
   1. Seed must be Blue Tagged Certificate Seed and must contain requirements indicated in PART 2 PRODUCTS, Lawn Seed, below. The contractor shall submit seed breakdowns tags to the University Representative for approval. Tags will be show percentages of seed varieties, weed seed, inert matter, and date of “Germination Test” done within a nine-month period prior to sale of the seed.
   2. Sod must be certified and must contain requirements indicated in PART 2 PRODUCTS Sod, below.

D. The contractor shall provide submittals indicating the type and application rates of fertilizers as recommended in accordance with the soil test.

E. Chemical Spraying Program: No Spraying of Herbicides, insecticides, fungicides nematicides, fumigants, or other chemicals shall be done without first submitting a spray program to the University Representative. Application of herbicides will only be permitted by licensed applicators. Applicators should consult any Chemical Hypersensitivity Registries for the area.

F. Product Data: For each type of product indicated.

1.6 QUALITY ASSURANCE

A. Seed Producer: Manufacturers specializing in grass seed production with minimum of 5 years experience and certified by the Pennsylvania Department of Agriculture as outlined in Title 3 (Agriculture) of the Pennsylvania Consolidated Statues.
   1. Seed: Must comply with all Commonwealth of Pennsylvania seed certifications.

B. Sod Producer: Manufacturers specializing in sod production and harvesting with minimum of 5 years experience and certified by the Pennsylvania Department of Agriculture as outlined in Title 3 (Agriculture) of the Pennsylvania Consolidated Statues.
   1. Sod: Minimum age of 18 months with root development that will support its own weight, without tearing, when suspended vertically by holding the upper two corners.

C. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment.
   1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

D. Perform work in accordance with all applicable laws, codes and regulations required by authorities having jurisdiction over such work and for all inspections and permits required by Federal, State, and local authorities in furnishing, transporting, and installing materials.

E. Certificates of inspection required by law for transportation shall accompany invoice for each shipment of seeds and sod. Submit copies of certificate after University Representative’s acceptance of material. Inspection by Federal or State Governments at place of growth does not preclude rejection of material at project site.

F. Comply with Federal Seed Act.
G. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Seed:
1. Each seed container shall be in sealed bags labeled by manufacturer and/ or grower indicating weight and analysis.
2. Bulk deliveries of seed shall be accompanied with delivery tickets specifying percentage germination, purity, and noxious weed content.
3. Seed shall be kept in dry storage away from contaminants, insects, and rodents.

B. Sod:
1. All sod shall be reviewed by the University Representative at the job site prior to installation. The University Representative reserves the right to reject any sod they deem unacceptable.
2. All sod delivered from the supplier shall be installed on the same day as delivered.
3. Each palette, flat, or specified group of sod shall be labeled by the grower or manufacture as separate items.
4. During harvesting, delivery, and storage, sod materials shall be protected from any drying or contamination by detrimental material.
5. Sod shall not be dropped or dumped from vehicles.

C. Fertilizer and Lime: Each container of fertilizer and /lime shall be labeled by manufacturer as separate items indicating weight and analysis of the container.

D. Topsoil: Shall not be muddy or frozen at time of grading.

E. Storage
1. Store products in accordance with producer’s recommendations and as noted.

1.8 PROJECT CONDITIONS

A. Protection of Existing Utilities:
1. Prior to any work being performed the contractor shall insure that all existing utilities within and surrounding the project site have been clearly marked in accordance with the Pennsylvania Underground Utility Line Protection Act, Act 287 as amended by Act 199.

B. Site Conditions:
1. Site and utility construction: Do not proceed with seeding or sodding operations until Henderson Building, walls, walks and terrace construction is completed or as directed by the University Representative.
2. Turf areas will be free of waste or debris developed by other trades. Any discrepancy from such conditions shall be reported to the University Representative before beginning any installation.

C. Planting Seasons:
1. Seeding: The Planting of turf sod specified on the drawings shall be performed during the following timeframe: April 1st and May 15th or between September 1st and October 15th.
2. Sodding: The planting of turf sod specified on the drawings shall be performed during the following timeframe: April 1st to October 31st.
3. Environmental: No seeding shall be done on frozen ground, when the temperature is 32 degrees F (or lower) or 90 degrees F or higher.
D. Protect existing utilities, paving, and all other facilities from damage caused by lawn installation operations.

E. Contractor is responsible for protecting newly sodded areas. Contractor shall take measures to reasonably reduce or minimize pedestrian traffic through Lawn Terrace areas during the lawn establishment period or as required to maintain lawn areas.

F. Water will be available on site, but the Contractor shall provide all manpower and conveyances such as water trucks, hoses, etc. to maintain soil moisture requirements to all lawn areas.

1.9 LAWN MAINTENANCE (Seed and Sod)

A. Begin maintenance of sodded lawns immediately after each area is installed and continue until acceptable lawn is established and final acceptance by the University Representative. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations.

B. Watering: Water shall be applied frequently enough to keep the grass and soil from drying out. The University shall provide the water source. The contractor is responsible for all hoses, sprinklers or other watering devices and he/she shall ensure proper backflow protection on the water source.

1. Water in a manner to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

C. All areas and spots that do not show a prompt catch of grass or signs of browning shall then be reseeded or re-sodded as required until complete coverage is obtained.

D. Mowing: When the average height of the grass reaches 3 to 4 inches, grass shall receive an initial mowing to a height of 2 to 3 inches or removal of 1/3 of the grass blade.

1. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height at a time. Remove no more than 1/3 of grass-leaf growth on subsequent mowings.

2. Do not delay mowing until grass blades bend over and become matted.

3. Do not mow when grass is wet and will mat.

E. Remediation: Any depressions or irregularities in the lawn surface shall be leveled off and reseeded or re-sodded.

1. Roll, regrade, and replant bare or eroded areas and re-sod to produce a uniformly smooth lawn.

F. Maintenance shall cease after the third cutting and final acceptance by the University Representative, provided all grass areas are properly established and free of washouts, depressions, bare spots, weeds, and large off-color areas.

1. If seeding or sodding is completed in the autumn, the Contractor shall complete the three cuttings in the following spring as required to establish an acceptable stand of turf grass.

1.10 ACCEPTANCE

A. Final Inspection: At the end of the maintenance period, the University Representative and the Contractor will make an inspection of the project turf grass areas.
B. Any lawn area under this contract that is not in satisfactory condition, as determined by the University Representative shall be reworked as soon as conditions permit. All reworked lawn areas shall be maintained as previously specified in SECTION 1.9 MAINTENANCE above, until final inspection and acceptance occurs.

PART 2 - PRODUCTS

2.1 LAWN SEED

A. Shall be clean and fresh, packaged in sealed bags showing net weight, composition of mix, date of germination tests and suppliers name.

B. Seed must be Blue Tagged Certified and must not contain more than 0.1% by weight weed seed, no more than 1.5% inert matter, no more than 0.1% other crop seed and no noxious weeds seed or undesirable grass species.

C. Composite of the mix shall contain 60% bluegrass, 20% fine fescue, and 20% ryegrass. The varieties are started as follows and no substitutions of mixes and/or percent of mixes is allowed.
1. Bluegrass: A maximum of 20% of each variety for a total of 60% (Three different Varieties)
   -America
   -Award
   -Awesome
   -Beyond
   -Freedom
   -Langara
   -Midnight II
   -Nudestiny
   -Nuglade
   -Quantum Leap

2. Fine Fescue: A maximum of 10% of each variety for a total of 20% (Two different Varieties)
   -Banner III
   -Bridgeport
   -Brittany
   -Jasper II
   -Longfellow II
   -Reliant II
   -Rescue 911
   -Shadow II
   -Treasure
   -Victory

3. Perennial Ryegrass: A maximum of 10% of each variety for a total of 20% (Two different Varieties)
   -Applaud
   -Cadence
   -Caddieshack
   -Cutter
   -Fiesta
   -Hawkeye
   -Jet
   -Mach I
   -Manhattan III
   -Topgun

2.2 LAWN SOD

A. Sod type shall be a Kentucky bluegrass blend consisting of 3 different varieties.

B. Sod shall be field grown in same climatic conditions as that of the project site.

C. Sod shall be strongly rooted, not less than 18 months old, free of weeds and undesirable native grasses. Furnish viable sod of uniform density, color and texture, strongly rooted and capable of vigorous growth and development when installed.
D. Sod shall be installed within 36 hours from the time it is cut. Do not allow sod to dry out during transport or on site storage.

2.3 WOOD CELLULOSE FIBER MULCH

A. Shall consist of especially prepared wood cellulose processed into uniform fibrous physical state.

B. Shall by dyed green or contain a green dye in the package that will provide an appropriate color to facilitate visual inspection of the uniformly spread slurry.

C. Shall contain no germination or growth inhibitors.

D. Shall be manufactured and processed in a manner that the wood cellulose fiber mulch will remain in uniform suspension in water under agitation and will blend with other additives to form a homogeneous slurry.

E. Shall form a blotter-like groundcover, on application, having moisture absorption and percolation properties and shall cover and hold grass seed in contact with the soil without inhibiting the growth of the grass seedlings.

F. Shall not contain elements or compounds at concentration levels that will be phyto-toxic.

G. Must conform to the following physical requirements.
   1. Fiber length to approximately 10mm. Diameter approximately 1mm.
   2. pH range of 4.0 – 8.5.
   3. Ash content of 1.6% maximum.
   4. Water holding capacity of 90% minimum.

2.4 TOPSOIL

A. Imported and or Salvaged Topsoil: See Section 32 9100.

PART 3 - EXECUTION

3.1 SITE PREPARATION

A. Prior to commencing any finished grading or seeding operations Contractor shall notify the University Representative allowing enough time for a thorough inspection of the Subgrade. Proceed with installation only after unsatisfactory conditions have been corrected and approved by the University Representative.

B. Prior to any work the Contractor shall have all utilities located by calling PA One-Call at (800) 242 1776.

C. Prior to grading, apply Round-up or other approved herbicide as per the manufacturer’s directions to eliminate any existing weeds. Allow sufficient time for the herbicide to take effect.

D. Provide protection to existing site features, structures, walls, and walks, etc., to prevent damage settlement, movement, undermining or erosion. Protect existing trees and landscape features.
E. Contractor shall move temporary protection, silt fencing, and other erosion control measures to complete the installation of this work. Reinstall and/or maintain inlets and swales as required by Pennsylvania State Erosion Control and as directed by the University Representative.

F. Grading: Perform all finished grading necessary to bring the site to the required finished elevations indicated on the grading plan and as noted in SECTION 32 9100.
   1. Apply 1” of approved organics over all areas to receive Sod.
   2. Hand rake and smooth out roto-tilled areas to remove all dirt clods, debris and stones larger than 1/2”, or other matter not conducive to the establishment of lawns.
   3. Protect all prepared fine graded areas to receive seed from damage from truck and foot traffic compaction. Failure to do so may require the contractor to regrade and repair soil prior to seeding operation.
   4. Obtain University Representatives approval of finish grades prior to the installation of sod. Make corrections and adjust grades as specified above. Restore damage resulting from lack of protection, or improper installation of protection, as approved by the University Representative.

3.2 PROTECTION

A. Protect sod to prevent damage from pedestrian traffic. Restore damage resulting from lack of protection or improper installation of protection during seeding and sodding operations.

3.3 SOD INSTALLATION

A. Install sod during favorable soil conditions. Soil shall not be frozen or in a saturated condition.

B. Lay sod directly on cleaned and raked areas laying in staggered rows, butting joints tightly together. Do not allow joints to separate greater than 1/2” apart. Spade cut sod along pavement and bed edges, do not tear apart.

C. Install sod on Lawn Terrace so that the top of sod soil line is slightly below (1”) from the top of the adjacent terrace paving or concrete surfaces, to allow for drainage off these surfaces

D. Maintain a minimum uniform slopes for positive surface drainage to drain inlets.

E. Roll sod with a lightweight roller to provide full soil/sod root contact.

F. Hand water sod immediately after installation. Sod shall be kept well watered and fertilized during the initial growing period, a minimum three weeks. DO NOT ALLOW SOD TO DRY OUT. Apply slow release fertilizer at rate recommended by manufacturer on fertilizer product.

3.4 LAWN RENOVATION

A. Renovate existing lawn.

B. Renovate existing lawn damaged by Contractor’s operations, such as storage of materials or equipment and movement of vehicles.
   1. Reestablish lawn where settlement or washouts occur or where minor regrading is required.

C. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury in soil.
D. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new topsoil.

E. Mow, dethatch, core aerate, and rake existing lawn.

F. Remove weeds before sodding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

I. Apply soil amendments and initial fertilizers required for establishing new lawns and mix thoroughly into top 4 inches of existing soil. Provide new planting soil to fill low spots and meet finish grades.

J. Apply sod and protect as required for new lawns.

K. Water newly planted areas and keep moist until new lawn is established.

3.5 LAWN ESTABLISHMENT & MAINTENANCE

A. Contractor shall water sodded lawn areas adequately to thoroughly moisten the sod bed and to produce an even stand of turf. Do not over water.

B. Maintain sod areas as required until final acceptance of the turf grass.
   1. Mowing:
      a. When grass reaches 3", mow to 2" in height.
      b. Maintain grass between 2 1/2" to 3 -1/2" height.
      c. Do not cut more than 33% of grass leaf in a single mowing.
      d. Remove grass clippings.
      e. Re-sod and mulch all spots, not having a uniform stand of grass.
   2. Weed eradication:
      a. If necessary, apply herbicide uniformly at manufacturer's recommended rate between the first and the third mowing.

3.6 PROTECTION

A. Protect all sodded areas from any foot traffic until the turf acceptance.

3.7 CLEAN UP

A. Perform cleaning during installation and upon completion of the work.

B. Remove from site all excess materials, soil, debris, and equipment. Repair damage resulting from installation operations in order to meet all contract document requirements in every respect.
SECTION 32 9300 - EXTERIOR PLANTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Work of this section describes the labor, materials, and installation requirements necessary to complete plantings with the highest possible quality standards:
   1. Planting area soil excavations and installation of underdrainage,
   2. Installation of trees, shrubs, and groundcovers,
   3. Mulches and planting accessories,

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Section 32 8400, Irrigation

B. Section 32 9200, Turf and Grasses

1.3 REFERENCES

A. Standards: Comply with applicable recommendations of the following:

B. "Standardized Plant Names", American Joint Committee on Horticultural Nomenclature.

C. "American Standard for Nursery Stock", The American Nursery & Landscape Association (ANLA), ANSI Z60.1-2004

1.4 DEFINITIONS

A. Initial Acceptance: Is defined as the event when the work is substantially completed and approved by the University Representative, and establishes the date for the Warrantee and Maintenance periods to commence.

B. Partial Acceptance: Is defined as the event when the work is substantially completed on a portion of the work and the contractor will be delayed one planting season from completing the remainder of the work. The University Representative may grant a partial acceptance for the approved portion of the work that qualifies, and will establish the date for the warrantee and maintenance period to commence only on the completed portion. Granting of partial acceptance shall also extend the Warranty period correspondingly.

C. Maintenance Turnover: Is defined as the date of maintenance transition for all plant material installed as part of this contract, over to the University with their knowledge and agreement. From that date the University will assume responsibility for the maintenance of all plant material.
D. Final Acceptance: Is defined as the event when the warrantee and maintenance periods are over, and the contractor has complied with all provisions of the contract documents, and the University Representative grants the contractor release from further contractual obligations as they pertain to the provisions specified only in this Section.

1.5 SUBMITTALS

A. Guarantee: Written guarantee warranting the plant material to be in healthy condition at the time of expiration of the 120 day "Landscape Establishment Period".

B. Contractors Qualifications: If the subcontractor has not been prequalified and accepted by the University, submit the following information:
   1. Installer qualifications, verifying years of experience.
   2. List of completed projects having similar Scope of Work identified by date, name, and location.
   3. A minimum of three current references with names and phone numbers to be contacted.

C. Plant material quantities shall be as shown on the Landscape Drawings. Submit the following items:
   1. The specific variety, quantity and size of plant to be provided,
   2. Nurseries, where plant material is to be obtained,
   3. Unit prices for each type and size,
   4. Submit a planting schedule showing dates for planting in each of the project site.

D. Product Data: Submit the following manufacturer's information and source data:
   1. Commercial fertilizers,
   2. Chemical additives,
   3. Organics,
   4. Lime,
   5. Iron Sulfate,
   6. Filter Cloth/Soil Separator,
   7. Erosion Control Fabric.
   8. Drainage Boards.

E. Material Samples: Submit one pound samples, packaged in plastic bags, to the University Representative for examination and approval prior to any landscape operations.
   1. Mulches,
   2. Salvaged Topsoil,
   3. Imported Topsoil,
   4. Organics,
   5. Soil mixes.

F. Warranty and Maintenance:
   5. Submit written warranty and maintenance agreement for all workmanship and materials specified.

1.6 QUALITY ASSURANCE

A. Installer Qualification: Not less than 5 years documented successful experience in installation of work similar to Work of this Project.

B. Standards: Comply with applicable recommendations of the following:

C. Plant Substitutions- Pre-Bid:
1. It is the landscape contractor’s responsibility to make every reasonable effort to find the plant material specified by the Project.
2. Contractor is also responsible for qualifying their bid, to document any plant suitability or availability problems.
3. Contractor may offer substitutions to the University Landscape Architect through the University Representative for consideration if there are legitimate availability problems.
4. Contractor may also offer substitutions if there are known diseases or insect resistant species that can be substituted for a pest prone plant, if specified.
5. Contractor shall submit a Base Bid as per plans and specifications, plus any price changes or clarifications for all recommended plant substitutions.

D. Plant Substitutions- Post-Bid, Pre Installation:
1. It is the intent to reduce or eliminate post-bid pre-installation substitutions by the contractor,
2. Substitutions of plant materials will not be permitted unless authorized in writing by University Landscape Architect or their designee.
3. If proof is submitted that any plant accepted during the bidding process is not attainable, a proposal will be considered for use of nearest equivalent size or variety, with corresponding adjustment of Contract price if necessary.
4. These provisions do not relieve Contractor of responsibility for obtaining required materials in advance if special growing conditions or other arrangements that must be made in order to provide the required materials.

E. Preliminary Plant Acceptance:
1. University Landscape Architect, University Representative or his designee may view plants at their place of growth or upon delivery. However, University Landscape Architect or University Representative reserves the right to tag plants at their place of growth.
2. The University has the right to make changes in plant types, provided they are of equal value and quantity prior to University Representative approvals and purchasing by the Landscape Contractor.
3. Identify place of growth and quantity of plants to be inspected.
4. For distant material, photographs may be submitted in lieu of on site inspections or for preliminary reviews prior to on site inspections and tagging.
5. Coordinate with the University Landscape Architect through the University Representative requests for plant inspection at their place of growth at least ten calendar days prior to digging.

1.7 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall contact the University Representative 24 hours prior to the delivery of any plant material.

B. All plant material shall be inspected by the University Representative at the job site upon delivery. Only plants approved by the University Representative shall be stored or planted.

C. The University Representative reserves the right to refuse any plant material they deem unacceptable. Any and all rejected plant material shall be removed from the job site on the day rejection.
D. Plant identification labels shall be durable and waterproof. Labels shall be securely attached to plants, bundlers, or containers of plants and shall state the correct botanical plant name and size. Labels shall not be removed from plants until final acceptance.

E. Bulk deliveries of mulch, topsoil, and inert material shall be accompanied with delivery tickets showing weight, origin, and composite and stored in such a manner as to prevent the inclusion of foreign materials.

F. Handling:
   1. Do not bind plants with wire.
   2. Use extreme care in handling all plant material. Move plants at their base. Avoid bending and twisting trunks that may weaken the plant balls.
   3. Plants damaged in transit, storage or handling may be rejected at the sole discretion of the University Representative. Contractor shall note that consideration for plant material damage may not be life threatening, but rather cosmetic such as broken branches or scratched trunks, to qualify plant for rejection.

G. Plant Storage:
   1. Trees, shrubs, and groundcovers not installed on the day of delivery to the site shall be stored and protected. NO PLANTS SHALL BE STORED ON THE SITE FOR A PERIOD GREATER THAN 5 BUSINESS DAYS.
   2. Storage locations shall be continually shaded and protected from the wind. Plants stored on the project site shall be protected from drying at all times, covering the balls or roots with moist woodchips, shredded bark, peat moss or other suitable heel-in material.
   3. Coordinate the temporary storage of plant material with the general contractor or other trades as required to keep plants away from ongoing construction activities.

1.8 SITE CONDITIONS

A. Utilities and Underground Features:
   1. Prior to any work being performed the Contractor shall insure that all existing utilities within and surrounding the project site have been clearly marked in accordance with the Pennsylvania Underground Utility Line Protection Act 287 as amended by Act199.
   2. If there is a conflict between utilities or other underground obstructions and plant material, coordinate with the University Representative for relocating plants prior to installation.

B. Concealed Contingencies:
   1. The correction of undisclosed or discovered subsurface conditions such as rock, roots, stumps, water, clay pan, soils contaminated with toxic substances or other site obstacles encountered in the excavation work, shall be brought to the attention of the University Representative prior to preceding.
   2. After determination that the discovered or undisclosed conditions are not the Contractor responsibilities, obtain written direction for changes to the design, or to proceed with pricing in order to obtain approvals to implement corrective measures.

C. Drainage:
   1. Every effort has been made to select plants suitable for the site conditions they will encounter, however, if plants are to be in areas that show obvious poor drainage contractor shall perform drainage tests as per Section 3.2.
   2. Poor Drainage areas encountered in the plant pit excavation work, which were not apparent at the time of Bidding, shall be brought to the University Representative’s attention.
3. Contractor shall make himself aware of subsurface under drains and building foundation drains that may be available for use in providing plant bed underdrainage. Verify with the Landscape University Representative drains that may be used.

D. Site Preparation:
1. Coordinate plant material installations with waterproofing, site utilities and irrigation.
2. Planting areas shall be free of waste or debris developed by other trades. Any discrepancy from conditions shall be reported to the University Representative before beginning any installation.
3. Coordinate removal of temporary tree protection devices required for the completion of this work with the University Arborist and Representative.
4. Do not commence this work until grades have been set and planters and drains are completed.

1.9 PLANTING SEASONS

A. General: No plants may be planted when the ground is frozen or during days of extreme heat (Greater than 80 Degrees). Plants shall be installed between March 1st and June 15th or from August 15th until the ground freezes. Any change from this planting season must be approved by the University Representative.

B. Perennials:
1. May be installed as soon as the ground is workable in the spring after March 1 until November 15.
2. No perennials to be planted between November 15 and March 1

C. Annuals:
1. Cold sensitive annuals may be installed after danger of frost has passed and as soon as the ground is workable in the spring after March 1 until November 15 for cool season annuals, after April 15 (or last risk of frost) and until September 15 for warm season annuals.

D. Spring Flowering Bulbs:
1. May be installed between October 30 and the ground freezes.

E. Excluded Material:
1. The following trees may only be installed in the spring season.
   a. Oaks (Quercus varieties), Flowering Dogwood Varieties, (Cornus florida), Sweet Gum (Liquidambar styraciflua) Tulip Poplar (Liriodendron tulipifera). Plants shall have been dug prior to leaf elongation.

1.10 WARRANTY PERIOD

A. Contractor shall warrant that all trees, shrubs, vines, groundcovers, perennials, and bulbs planted under this Contract will be healthy and in flourishing condition of active growth for a Warranty Period of 120 days from date of completion and initial acceptance of the work.

B. Any delay in completion of planting operations, which extends the planting into more than one planting season shall extend the Warranty period correspondingly.

C. Contractor shall provide written warrantee certificates to the University Representative.
D. Warranty Provisions:
1. Remove plants that are in the opinion of the University Representative or University, at least 25% dead, unsightly, or not in healthy condition.
2. Replace removed plants, and plants missing due to Contractor's negligence. Replace when weather conditions permit and within specified planting period, or as directed by University Representative.
3. Provide replacement plants closely matching adjacent specimens of same species.
4. Warrant replacement plants for additional period of one year from date of their acceptance after replacement. Note that failure to replace plants in a timely and responsive manner may result in reduction and/or forfeiture of final payments.

1.11 MAINTENANCE

A. Begin maintenance immediately after plants are installed and continue for the 120-day maintenance warrantee period.

B. Maintenance Requirements:
1. Protect plants and planting areas from damage.
2. Keep plants healthy, vigorous, trim, and neat.
3. Prune to maintain plants in normal growth pattern.
4. Spray to control disease and insects.
5. Maintain mulch bed to 2-inch depth at trees and large shrubs, 1-½” for small shrubs, ½”-1” for perennials. Note: complete re-mulching of plant materials is not required as part of the contract.
6. Keep beds free of weeds.
7. Provide manpower in order to water or operate the irrigation system, all plant materials as required to maintain adequate moisture, and when directed by University Representative.
8. Maintain stakes and guys with enough tension to hold the trees stably with wires in place and safety flags clearly visible. Remove stakes and guys when no longer necessary for plant establishment, no later than one year after installation.
9. Reset plants to proper grade and upright condition if required and add topsoil and mulch to areas of settlement.
10. Provide additional stakes as required to support trees particularly evergreens in areas prone to high winds or settlement.
11. Maintain all plants until final acceptance by the University Representative and turnover of maintenance activities to the University.

1.12 ACCEPTANCE

A. Initial Acceptance:
1. Notify University Representative ten calendar days prior to date Contractor wishes the University Representative to view the progress of the work and to prepare final landscape punch lists on completion of the planting.
2. University Representative will view Work for conformance with Contract Documents. Work will be accepted provided that all requirements have been complied with, punch list items have been completed, and receipt of plant material warrantee certification.
3. When all items have been satisfied the University Representative will issue a Notice of Initial Acceptance and a Date for commencement of Warrantee timetable and start of maintenance period.

B. Partial Acceptance:
1. Acceptance may be made on partially completed Work, if approved by University Representative.
2. If Work has stopped for reasons beyond Contractor's control acceptance will be made on partially completed Work.

3. University Representative will view Work for conformance with Contract Documents. Work will be partially accepted provided that all requirements, including punch list items for those particular items have been complied with, and that plants are alive and in healthy, vigorous condition.

4. When all items have been satisfied the University Representative will issue a Notice of Partial Initial Acceptance and a Date for commencement of warrantee timetable and start of maintenance period for those areas.

C. Maintenance Turnover:
1. Prior to Final Acceptance an agreed date of Maintenance Turnover shall be confirmed by the University Representative in writing and shall be signed off, by the University and the Contractor prior to an end of on going plant maintenance activities and responsibilities.
2. Contractor shall meet with University Representative and University's representative to review and advise of general maintenance procedures prior to Maintenance Turnover.

D. Final Acceptance:
1. Notify University Representative one month prior to expiration of Warrantee period that Final Acceptance is required.
2. University Representative will review landscape and maintenance Work for conformance with Contract Documents, and note any plants requiring adjustments or replacement. University Representative will issue a letter of outstanding items.
3. The University Representative will issue final Acceptance letter, when all requirements are satisfied and contractor is released from further contractual obligations.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Manufacturers offering products that comply with the requirements of this Section are listed below. Those manufacturers not listed but do offer products that comply with the requirements of this Section will be considered as substitute manufacturers, requiring the University Representatives approval.

2.2 PLANT MATERIAL

A. Quality Assurance:
1. Plants shall be of the quality and quantity indicated, true to name, properly labeled with scientific name and in accordance with the sizes and grades specified.
2. Plants shall be nursery grown, have a habit of growth that is normal for the species, and shall be sound, health, vigorous, free from insect pests, plant diseases and injuries, and shall have normal root systems.
3. All plants shall be equal or exceed the measurements specified in the plant list
4. Provide plants of "specimen quality", heavy, and symmetrical. Plants shall be tightly knit where specified on the plant material schedule.
5. No excessive tip pruning or shearing of evergreens or deciduous trees is permitted. Plants shall exhibit a natural quality.
6. Any branches with included bark shall be of a quantity and placement so that they will not significantly affect the scaffold structure of the tree if removed within the first two years after transplant.
B. Size:
1. Comply with measurements on Plant Schedule except plants larger than specified may be used if acceptable to University Representative, and at no change to Contract sum.
2. Plants shall be measured before pruning, with branches in normal position. Any necessary pruning shall be done at the time of planting.
3. Requirements for the measurement, branching, grading, quality, balling, and burlapping of plants shall follow the code of standards currently recommended by the American Association of Nurseryman, Inc. in the American Standards for Nursery Stock, ANSI Z60.1, current edition.
4. If larger plants are accepted, increase ball of earth in proportion to size of plant.
5. If size range is given, comply with minimum sizes while providing an average size that is in the mid-point of the range.

C. Nursery Cultivation:
1. Provide plants that are nursery grown in accordance with good horticultural practices, and shall conform to ANSI Z60.1.
2. Balled and Burlapped Plants: Shall have balls of earth of sufficient diameter to be in accordance with the size of the plant, of sufficient depth to include an adequate root system, and shall be properly balled, burlapped, and secured.
3. Local soils matching site soils where applicable are preferred.
4. Dig plants fresh for delivery to the project during season for planting. Should time table for plant installation be out of phase with recommended planting times please notify University Representative so that an alternative plant digging schedule can be approved.
5. Oaks for example require a spring harvesting just prior to leafing out. No B&B heeled-in plants, out of season dug, or plants from cold storage will be accepted, without prior knowledge and written acceptance from the University Representative.
6. Container Grown Plants: Shall be healthy, vigorous, well rooted, and established in the container in which they are sold. Plant development shall be sufficient so that they root mass will hold together when removed from the container. Remove plastic containers before planting.
7. Do not prune trees before delivery.
8. Trees shall have a minimum of pruning wounds that have not grown over.

2.3 SOILS
A. See Section 32 9100 for specifications regarding soils and soil planting mixes.

2.4 FERTILIZERS AND AMENDMENTS
A. Commercial Fertilizers: In accordance with the soils analysis, and recommendations, fertilizers shall be in bags showing weight, analysis, and manufactures name.

B. Organic Amendments: In accordance with the soil test recommendations, organic shall be as per those specified in Section 32 9100 Planting Soils.

2.5 HERBICIDES
A. Non-Selective Herbicide shall be ROUND-UP as manufactured Monsanto or approved equal.

B. The spraying of all herbicides must be done in accordance with the Chemical Spraying Program.
2.6 PLANTING ACCESSORIES

A. Filter Cloth / Soil Separator:
   2. Acceptable products and manufacturers:
      a. Mirafi by Mirafi Inc.
      b. Stabilenka Type T-80 by American Enka Co., or approved equals.

B. Erosion Control Fabrics: For slopes greater than 15%, or flow velocities greater than 12fps, or as directed by the University Representative.
   1. Conwed Fibers, erosion control netting, Delanco Rd. Riverside NJ 08075,
   2. Miramat, by Mirafi Inc.
   3. BonTerra Erosion Control Blanket, or approved equals.

C. Staking and Guying: Tree stakes shall be 2-inch x 2-inch hardwood, reasonably free of knots, and a minimum 6 feet long with two feet in the ground.
   1. Guying shall consist of nylon straps wrapped loosely around the trunk.

D. Drain and Trench Lines and Foundation Drain Boards:
   1. 4” diameter Schedule 40 PVC piping,
   2. Advanced Drainage Systems (ADS) N-12 or approved equal (smooth-walled interior).
      a. Provide 3 to 4-inch size perforated flexible drain lines.
   3. MiraDrain AFD System, or approved equal.
      a. Provide MiraDrain types 6000, 6000XL, for foundation and retaining wall applications.
      b. Provide MiraDrain types 5000, for trench drain applications.

2.7 AGGREGATES

A. Double Washed Bank Gravel:
   1. Provide clean washed gravel clear of fines complying with ASTM C33, Size 8 or 9 (3/4”) for use associated with required drain lines for improving soil drainage or approved equal.

B. Lightweight Aggregates:
   1. Provide lightweight aggregates to improve drainage in On-structure plantings or where soil weight will be a problem.
   2. Provide clean Solite, Isolite, or approved equal size 8-9 (3/4”), for under drainage.
   3. Also provide clean Solite, Isolite, or approved equal size 12-15 (3/8”), in soils to improve soil porosity and drainage.

2.8 MULCH & TOP DRESSINGS

A. Organic Mulch: Shall be coarse, fibrous, shredded hardwoods, free of dyes, sufficiently aged to prevent adverse reactions to plant material and subject to approval by the University Representative.

B. Provide screened pine fines for annual or perennial planting areas.
PART 3 - EXECUTION

3.1 EXAMINATION OF SITE CONDITIONS:

A. Contractor shall be responsible for making themselves familiar with all underground utilities, pipes and structures, by contacting a local Utility locating service 72 hours prior to digging. Contractor shall take sole responsibility for any cost incurred due to damage to these utilities.

B. Protect of Existing Vegetation: All existing vegetation to remain shall be protected at all times in accordance with Section 01 3956 – Temporary Tree and Plant Protection.

C. Examine conditions in which Work is to be installed. Do not proceed with Work until unsatisfactory conditions are corrected. Do not install soils or plants prematurely when the site and planters are not ready for plants or when construction conditions may damage installed material.

D. Do not willfully proceed with planting as designed when it is obvious that conditions and/or obstructions exist due to changes in building or site conditions. Such conditions shall be brought to the immediate attention of the University Representative. The Contractor may be held responsible for all necessary replanting due to failure to give notifications so that material can be relocated or conditions corrected prior to plant installations.

E. Remove any existing plant material necessary for the installation and the completion of the planting designed and contracted as part of this project.

F. Plant layout staking:
   1. Layout of plants prior to planting shall be verified by the University Representative. Any alterations to be planned layout must be approved by the University Landscape Architect and/or the designer.
   2. Stakeout ground locations in the field for trees and outlines of plant beds.
   3. Review staked layout in field with University Representative or field representative prior to planting.

3.2 PLANT MATERIAL PREPARATION:

A. Digging Plants at Nursery:
   1. Dig balled and burlapped (B&B) plants with firm, natural balls of earth of diameter not less than that recommended by American Standard of Nursery Stock; of sufficient depth to include fibrous and feeding roots. A larger than minimum ball size may be necessary to meet this requirement.
   2. Plants with cracked or broken balls are not acceptable.
   3. Remove dirt thrown onto ball top by cultivation and other nursery practices prior to digging.
   4. Root flare must be visible or structural roots must be present within the top two inches of the ball.
   5. Do not provide plants with incorporated encircling roots or that have had adventitious roots.

B. Mark north-facing side of all trees greater than 4-1/2" caliper at place of growth, and position trees in similar exposure at installation. Final positioning is to be approved by University Representative.
3.3 SOIL DRAINAGE TESTS:

A. Before planting, determine that areas to receive plant material have adequate sub–drainage, and that the Drainage installed is functioning. Contractor is responsible for correcting all drainage conditions, which may adversely impact the establishment of specified plantings.

1. Perform water percolation tests for the following areas or as required:
2. General planting areas at low spots or where the soils may be overly compacted or drain poorly such as locations under previously paved areas, minimum two tests;
3. Side lawn areas in spots where the soils may be overly compacted or poorly drain due to construction activities, perform minimum 2 tests;
4. Under or near one of the large ornamental trees, perform 1 test;
5. Total-5 tests.
6. Test by digging tree and shrub pits to the full depth and dimensions indicated on drawings.
7. Fill excavations to 1/3 depth with water and time percolation rate. A rate of one per is the allowable minimum percolation rate. Allow all water to percolate out before planting.
8. If, after 24 hours, water remains in excavation, perform a more detailed percolation test as described below and notify University Representative in writing.
9. At bottom of planting pit, excavate rectangular pit 12 inches by 12 inches by 18 inches deep. Pour water into this small pit to a depth of 6 inches (approximately 3 - 3 3/4 gallon). Note time required for water to be completely absorbed. Divide time noted by 6, to achieve average rate of absorption for 2 inches of water.

3.4 GENERAL PLANT INSTALLATIONS

A. Planting Bed Preparation:

1. The grouping of two or more plants shall constitute a planting bed or area. All unwanted vegetation shall be completely removed and hauled off site or sprayed with herbicide, in accordance with the Chemical Spraying Program, to ensure that planting beds are completely weed free.
2. If groundcover of a type normally specified in flats or pots of a 1-Gallon size or smaller is specified, the soil in the entire planting bed areas will be loosened by rototilling or similar means to a depth of 6 inches.

B. Plant Pit Excavation:

1. All planting pits shall be excavated to the depth of the existing root ball and planted on undisturbed soil. All construction debris such as plaster, concrete, stone, brick, wood, or other deleterious materials shall be removed.
2. Remove all trash, brickbats, debris or other material not contusive to plant material growth. Remove all soil contaminated by site masonry work.
3. Notify University Representative for corrective measures, if rock, tree roots, or other underground obstructions are encountered that would be detrimental to growth of plant material or require the tree to be shifted.
4. All tree pits shall be excavated circular with vertical sides. The diameter of pits for the tress and B&B shrubs shall be at least 2 feet greater than the diameter of the rootball or spread of roots.
5. Soils used for Planting shall comply with those of Section 32 9100, Planting Soils. Remove all poor soils, gravel, etc., not contusive to good plant growth.
6. If an impervious, hardpan layer remains in bottom of the pit after excavation the University Representative shall be notified prior to any additional planting activities to inspect the excavations and develop an alternate course of action.

C. Plant Installations:
1. **General:** The plant shall be set in its planting pit in such a manner that allows the bottom of the trunk flare to set 1 inch above finished grade. **NOTE:** THE TOP OF THE ROOTBALL IS NOT NECESSARILY THE BOTTOM OF THE TRUNK FLARE.

2. **Bare Root:** Build a cone of soil in the bottom of the planting pit. Place the plant in the hole, spreading the roots around the surface of the cone of soil. Gently backfill, firming the soil as you go.

3. **Balled and Burlapped:** Once the plant is set in its planting pit and at proper grade in relation to the surrounding spoil, the soil, the Contractor shall remove all wire, twine and burlap or other deleterious material.

4. **Containerized:** When the contractor removes the root ball from its container he/she shall inspect the root ball thoroughly for circling or girdling roots. The root ball shall then be scored to discourage girdling and promote the growth of feeder roots.

5. **Set plants plumb and brace rigidly in position until planting soil is tamped solidly around ball and roots.**

6. **Cut away and remove burlap, rope, wire basket etc. from the top 1/3 and sides of root balls. Remove completely where possible.**

7. **Settle backfill and eliminate voids and air pockets.**

8. **When backfill is complete water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed.**

9. **Place a 2" layer of approved shredded hardwood mulch.**

10. **At contractors discretion or if required due to plantings in high wind areas, stake as per recommended staking requirements as shown on the planting details.**

**D. Backfilling:**

1. Use specified backfill medium around the roots, filling the hole about two thirds full, and firm the soil around the root ball and /or roots.

2. Water the plant well immediately after backfilling to insure proper settling of soil around the roots. Allow the water to soak down and fill the remainder of the hole with loose soil without further packing or tamping.

3. Prepare a mound of soil around the edge of tree pit to form a shallow saucer.

**E. Pruning:**

1. Prune all dead or broken branches at the time of planting.

**F. Mulching:**

1. Mulch all plants and planting beds or areas with a 3-inch layer of specified mulch. It shall entirely cover the area of the planting pit, bed, or saucer around each plant. **DO NOT MULCH NEXT TO THE MAIN STEM OF THE PLANT.**

2. Planting saucers are not required in planting beds.

**G. Groundcovers and Perennials:**

1. In planting areas specified for Annuals or Perennials, top dress beds with a 1/2-inch to 1" layer of pine fines.

2. Smooth beds to conform to grades and adjust for settlement.

3. Layout plants for each bed by spacing them in staggered rows aligned with the outer edge of the planting beds.

4. Set plants at equal distance apart as indicated on the plant schedule.

5. Dig planting holes with hand trowel, large enough to allow for spreading roots.

6. Before planting, crush biodegradable pots and remove tops below soil level, and remove non-biodegradable pots. Set plants in planting hole and backfill soil by hand setting plants plumb, and straight.

7. Install plant so that level of root crown after settlement is same elevation at which it grew in nursery or pot.

8. Plant so that each root ball has good soil to root contact. Do not plant in mulch, but below mulch level.
9. Cover bare root plants up to crown of plant soil level.
10. Water after placing final layer of backfill and mulch.

H. Bulbs:
1. Plant bulbs at equal depths, appropriate to their species. (General rule is to plant at a depth equal to 3 times the size of the bulb).
2. Cover bulbs with minimum soil as indicated on the plant materials schedule.
3. Replace and smooth mulch layer and water.

3.5 STAKING AND PRUNING
A. Staking and guying plants shall be done immediately after trees are planted using specified staking materials.
B. Trees shall stand plumb prior to staking.

3.6 PROTECTION
A. Protect newly planted areas. Take measures to reasonably reduce or minimize pedestrian traffic from bed areas throughout the plant establishment period or as required to maintain plants.
B. Maintain adequate soil moisture for the proper establishment of all plants. Do not over water.
C. Restore damage, resulting from lack of protection or improper installation of protection as approved by the University Representative.

3.7 MAINTENANCE
A. Contractor shall be responsible for providing the following maintenance on all newly planted trees, shrubs, groundcovers, and herbaceous perennials.
1. Water: During periods of inadequate rainfall, as determined by the University Representative, all plant material shall be watered to maintain a constant suitable moisture level for adequate plant growth.
2. The Contractor shall be responsible for providing all watering hoses and other watering devices. The University will provide the water source.
B. Insect, Disease, and Weed Control: Weed control shall be by mechanical or hand weeding. The use of herbicides, insecticides, fungicides, nematicides, and fumigants or other chemicals are only acceptable upon approval by the University under provisions of the Chemical Spraying Program.

3.8 ESTABLISHMENT PERIOD
A. The Establishment Period will begin upon notice of substantial completion by the Contractor and inspection by the University Representative and will last for a total 120 day during the growing season.
B. The growing season is defined as the period between April 1st and November 1st. If planting occurs in the autumn, the Establishment Period will carry over to the next growing season until a total of 120 Days have been established.
C. Plants shall be guaranteed during the Establishment Period and shall be alive and in satisfactory growth at the end of the period. Plants, which die within the establishment period, will be removed by the Contractor within five (5) business days of notice or the University will remove the plants and bill the Contractor accordingly.

D. Replacement plants may be installed during the next appropriate planting season for the specified in the plant list.

E. All replacements shall be plants of the same kind and size specified in the Plant List. They shall be furnished and planted according to all previous specifications noted and shall be guaranteed through an additional 120 days Establishment Period, outlined above.

F. The cost of replacement shall be borne by the Contractor, except for possible replacements resulting from removal, loss or damage due to vandalism, or act of neglect on the parts of others.

3.9 FINAL INSPECTION AND ACCEPTANCE

A. At the end of the Establishment Period, an inspection will be made by the University Representative and the Contractor. Any plant determined to be of insufficient quality or unsatisfactory growth, as determined by the University Representative, shall be removed from the site and replaced at the Contractor's expense, as outlined in section 3.8 Establishment Period.

END OF SECTION 32 9300
SECTION 32 9510 LAWN TERRACE ROOF ASSEMBLY

PART I GENERAL

1.1 SUMMARY
A. The work in this section includes all labor, materials, and installation methods for:
1. Preparation and installation of the waterproof membranes, root protection mat, Drainage media and conveyance and soils for the Lawn Terrace area over the Henderson Auditorium roof structure.
2. Coordination with other trades for the installation of seat walls, paving, and irrigation systems.
3. Coordination with architectural waterproofing and insulation systems to facilitate the successful installation of the waterproofing membranes not specified here.

1.2 RELATED SECTIONS AND REFERENCES
A. Related Sections:
1. Section 03 30 53 – Cast-in-Place Concrete
2. DIVISION 07 Thermal and Moisture Protection
3. DIVISION 07 Insulation
4. DIVISION 07 Caulking and sealants
5. Section 32 84 00 – Irrigation
6. Section 32 92 00 – Turf and Grasses

1.3 REFERENCES
B. Underwriters Laboratories (UL) Class A.

1.4 DEFINITIONS
A. Green Roof -- An area of planting/landscaping, built up on a waterproofed substrate at any level that is separated from the natural ground by a man-made structure.
B. Shallow-Intensive/Lawn Green Roof -- Landscaping requiring more regular maintenance than an extensive condition but limited in plant selection due to shallower soil depths, (i.e., sod grass lawn).
C. Garden Roof® -- Patented system of drainage, water retention and root barrier components utilized in the construction of green roofs over Hydrotech’s MM 6125EV® roofing membrane.
D. Curve Number (CN) -- A number that is used with Natural Resource Conservation Service (SCS) methods to convert rainfall depth into runoff volume. The Curve Number takes into account a site’s soil type, plant cover, impervious cover, interception and surface storage.

1.5 SYSTEM DESCRIPTION
A. Furnish and install a completed Shallow-Intensive/Lawn Garden Roof® Assembly including, surface conditioner, Monolithic Membrane 6125EV®-FR and flashings, protection course, root barrier
protection, STYROFOAM® brand insulation, drainage/water retention component, filter fabric, lightweight engineered growing medium (soil).

1.6 SUBMITTALS

A. Certification from an approved independent testing laboratory experienced in testing rubberized asphalt material, that the material meets the CGSB-37.50-M89 standard for rubberized asphalt membranes, including applicable ASTM procedures.

B. Certification showing full time quality control of production facilities responsible for the manufacture of the rubberized asphalt and that each batch of material is tested to insure conformance with the manufacturers published physical properties.

C. Certification showing that all components of the green roof assembly are being supplied and warranted by a single-source manufacturer.

D. Documentation that the roof membrane assembly is currently Class A listed with Underwriters Laboratories.

E. Documentation that the extruded polystyrene insulation if used is free from CFC's.

F. The plant manufacturing the rubberized asphalt material shall have ISO 9001-2000 approval as evidenced by a notarized copy of the official certificate.

G. Provide product data on all components of the green roof assembly.

1.7 QUALITY ASSURANCE

A. The Roofing/Waterproofing Contractor shall demonstrate qualifications to perform the work of this Section by submitting the following documentation:
   1. Certification or license by the membrane manufacturer as a locally based, authorized applicator of the product the installer intends to use, for a minimum of five (5) years.
   2. List of at least three (3) projects, satisfactorily completed within the past five (5) years, of similar scope and complexity to this project. Previous experience submittal shall correspond to specific membrane system proposed for use by applicator.
   3. Include single-source for all components from the manufacturer.

B. The rubberized asphalt membrane product shall contain an inert clay filler and crumb rubber to enable the product to be resistant to acids (fertilizers, building washes and acid rain) and maintain membrane thickness during application.

C. Membrane Manufacturer shall have available an in-house technical staff to assist the contractor, when necessary, in application of the products and final inspection of the assembly.

D. Membrane Manufacturer Qualifications: Manufacturer shall demonstrate qualifications to supply materials of this section by certifying the following:
   1. Membrane Manufacturer shall show evidence that the specified rubberized asphalt has been manufactured by the same source for fifteen (15) years and successfully installed on a yearly basis for a minimum of fifteen (15) years on projects of similar scope and complexity.
   2. Membrane Manufacturer shall not issue warranties for terms longer than they have been manufacturing their hot fluid rubberized asphalt membrane.
E. Green roof supplier shall provide data and calculations to verify that the green roof assembly meets the project criteria for storm water runoff volume and rate control.
   1. Calculations shall be based on actual testing of suppliers' green roof components to be used for the project including but not limited to the growing media formulation and water retention/drainage materials.
   2. Calculations shall account for vegetated and un-vegetated portions of the roof and local climatic conditions including rainfall depth, intensity, duration, and timing.

F. Green roof supplier shall provide data demonstrating that the composite C-factor and Curve Number parameters for the specified green roof assembly are less than or equal to those factors used in the engineering design and analysis for the projects drainage and storm water systems analysis.

G. Pre-Construction Conferences. The manufacturer will meet with the necessary parties at the jobsite to review and discuss project conditions as it relates to the integrity of the roofing assembly.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original unopened containers of packaging clearly labeled with manufacturer's name, brand name, instruction for use, all identifying numbers, and U.L. labels.

B. Materials shall be stored in a neat, safe manner, not to exceed the allowable structural capacity of the storage area.

C. Store materials in a clean, dry area protected from water and direct sunlight.

D. Store all adhesives at temperatures between 60°F (15.5°C) and 80°F (26.6°C). If exposed to lower temperatures, restore materials to 60°F (15.5°C) minimum temperature before using.

1.9 PROJECT CONDITIONS

A. Application of the membrane shall not commence nor proceed during inclement weather. All surfaces to receive the membrane shall be free of water, dew, frost, snow and ice.

B. Application of membrane shall not commence nor proceed when the ambient temperature is below 0°F (-17.7°C).

C. Preparation and application of membrane shall be conducted in well-ventilated areas.

D. Over its service life, do not expose membrane or accessories to a constant temperature in excess of 180°F (82°C) (i.e., hot pipes and vents or direct steam venting, etc.).

E. Adhesives contain petroleum distillates and are extremely flammable. Do not breathe vapors or use near an open fire. Do not use in confined areas without adequate ventilation. Consult container or packaging labels and Material Safety Data Sheets (MSDS) for specific safety information.

F. Do not allow waste products (petroleum, grease, oil, solvents, vegetable or mineral oil, animal fat, etc.) to come in contact with the roof membrane. Any exposure to foreign materials or chemical discharges shall be presented to membrane manufacturer for evaluation to determine any impact on the roof membrane assembly performance.

G. Concrete Deck Surface Condition. IMPORTANT - Refer to 1.2 Related Sections.
H. Deck Preparation; refer to Section 3.02 Preparation.

I. General Contractor shall assure that adequate protection is provided after installation so other trades do not damage membrane.

1.10 WARRANTY

A. Upon completion of the work, the contractor shall supply the owner with a single-source warranty of U.S. origin direct from the manufacturer.

B. Each warranty varies in scope and terms. Contact Hydrotech for exact warranty terms and conditions to meet the specific project requirements.

C. Warranties available from the manufacturer:

1. Material Warranty: excludes labor.
   Duration: 20-year

2. Water-tightness Warranty: includes labor and material to maintain watertight condition and replacement of Hydrotech supplied roof substrate board.
   Duration: 20-year

3. Thermal Warranties: includes 80% retention of the original thermal value and remain on the deck at 70 mph wind gust. Duration 20-year

4. Total System Warranties; covers components of the green roof assembly, including membrane, flashing, insulation, Garden Roof® components and pavers. Includes removal and replacement of the Garden Roof® components, pavers and soil (≤24 inches deep) when supplied by and installed per Hydrotech’s requirements and replacement of Hydrotech supplied roof substrate board.
   A. Duration of Membrane/Flashing: 20-year
      (water-tight condition)
   B. Duration of Insulation: 20-year
      (80% of original thermal value; remain on the deck withstanding wind speeds not to exceed 70 mph)
   C. Material Integrity of Garden Roof® Components: 10-year
   D. Duration of Pavers: 10-year
      (will not crack, split or disintegrate due to freeze-thaw)

PART 2 - PRODUCTS

2.1 GENERAL

A. All components shall be obtained as a single-source from the membrane manufacturer to ensure total system compatibility and integrity.

Manufacturer: American Hydrotech, Inc.
303 East Ohio Street
Chicago, Illinois 60611-3318
800-877-6125 or 312-337-4998
FAX: 312-661-0731
Web Site: http://www.hydrotechusa.com
2.2 MATERIALS

A. Membrane:

1. Membrane shall be a hot, fluid applied, rubberized asphalt membrane meeting the CGSB-37.50-M89 standard and other pertinent physical properties:

2. American Hydrotech, Inc., Monolithic Membrane 6125EV® (up to 25% post-consumer recycled-content)

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>TYPICAL RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash point</td>
<td>ASTM D-92, CGSB-37.50-M89</td>
<td>&lt;500°F* (260°C)</td>
</tr>
<tr>
<td>Penetration</td>
<td>ASTM D-5329, CGSB-37.50-M89</td>
<td>98 mm @77°F (25°C), 187 mm @122°F (50°C)</td>
</tr>
<tr>
<td>Flow</td>
<td>ASTM D-5329, CGSB-37.50-M89</td>
<td>1.0 mm @140°F (60°C)</td>
</tr>
<tr>
<td>Toughness</td>
<td>CGSB-37.50-M89</td>
<td>16.0 Joules</td>
</tr>
<tr>
<td>Ratio of Toughness to Peak Load</td>
<td>CGSB-37.50-M89</td>
<td>0.069</td>
</tr>
<tr>
<td>Water Vapor Permeability</td>
<td>ASTM E-96, PROCEDURE E, CGSB-37.50-M89</td>
<td>0.3 ng/Pa(s)M²</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>CGSB-37.50-M89</td>
<td>.11 gram weight gain</td>
</tr>
<tr>
<td>Low Temperature Flexibility (-25°C)</td>
<td>CGSB-37.50-M89</td>
<td>No delamination, adhesion loss, or cracking</td>
</tr>
<tr>
<td>Low Temperature Crack Bridging Capability</td>
<td>CGSB-37.50-M89</td>
<td>No cracking, adhesion loss, or splitting</td>
</tr>
<tr>
<td>Heat Stability</td>
<td>CGSB-37.50-M89</td>
<td>No change in viscosity, penetration, flow or low temperature flexibility</td>
</tr>
<tr>
<td>Viscosity</td>
<td>CGSB-37.50-M89</td>
<td>11.0 seconds</td>
</tr>
<tr>
<td>Water Resistance (5 days/50°C)</td>
<td>CGSB-37.50-M89</td>
<td>No delamination, blistering, emulsification, or deterioration</td>
</tr>
<tr>
<td>Softening Point</td>
<td>ASTM D-36</td>
<td>180°F (82°C)</td>
</tr>
</tbody>
</table>
Elongation
ASTM D-5329 1000% minimum

Resiliency
ASTM D-3407 40% minimum

Bond to Concrete
ASTM D-3407 Pass
0°F (-18°C)

Acid Resistance
ASTM D-896 Procedure 7.1 (N-8) Pass-50% Nitric Acid
-50% Sulfuric Acid

Resistance to Hydrostatic Pressure
ASTM D-08.22 Draft 2 100 psi
(equals 231 foot of head water)

Resistance to Salt Water
ASTM D-896 similar 20% sodium chloride sodium carbonate calcium chloride
No delamination, blistering, emulsification or deterioration

Resistance to Fertilizer
ASTM D-896 similar undiluted, 15/5/5, nitrogen/phosphorus/potash
No delamination, blistering, emulsification or deterioration

Resistance to Animal Waste
3-year exposure No deterioration

Solids Content
100%-no solvents

Shelf Life
10 years (sealed)

Specific Gravity
1.23 + .02

*102°F more than the application temperature recommended by the manufacturer.

B. Surface Conditioner:
1. Asphaltic surface conditioner for concrete surfaces only. American Hydrotech, Inc., Surface Conditioner

C. Reinforcing:
2. 60-mil (1.5 mm) thick, uncured neoprene (heavy duty) reinforcing sheet. American Hydrotech, Inc., Flex Flash UN®

D. Flashing:
1. 60-mil (1.5 mm) thick, uncured neoprene sheet - American Hydrotech, Inc., Flex Flash UN®

E. Adhesives/Sealant:
1. Contact adhesive to bond elastomeric flashing together - American Hydrotech, Inc., Splicing Cement
2. Contact adhesive to bond elastomeric flashing to an approved substrate - American Hydrotech, Inc., Bonding Adhesive
3. Sealant to seal elastomeric flashing seam edge - American Hydrotech, Inc., Lap Sealant
F. Separation/Root Barrier Protection Course
1. 160-mil thick polyester reinforced, modified asphalt sheet with granular surface and root inhibiting additive. –American Hydrotech, Inc., Hydroflex® RB

G. Insulation:
1. Extruded polystyrene rigid board insulation for use above membrane. - STYROFOAM® Brand insulation Plazamate as manufactured by The Dow Chemical Company, marketed by American Hydrotech, Inc.
   a. Insulation shall meet ASTM C-578, Type VII.
   b. Minimum compressive strength, ASTM D-1621, 40 or 60 psi (276 or 414 kPa) (variance by type of product)
   c. Maximum water absorption by volume per ASTM C-272, 0.1%
   d. Water vapor permeance for 1" product per ASTM E-96, 1.0 perm (max.) (63 ng/Pa/s/m²)
   e. Insulation shall have an R value of 5.0°F ft² h/Btu/in. (0.88 K m²/W) of thickness when tested at 75°F (23.9°C) mean temperature in accordance with ASTM C-518
   f. Product shall be free of CFC's

H. Air Layer
1. Required air space over STYROFOAM® insulation when moisture mat is required shall be composed of a crush-proof core and non-woven filter fabric - American Hydrotech, Inc., Hydrodrain 300.

I. Drainage/Water Retention Component (Edit to project requirements, consult Hydrotech)
1. Three-dimensional, molded panels of recycled polyethylene with drainage channels top and bottom sides and water retention reservoirs top side - American Hydrotech, Inc., Gardendrain®
2. Shallow-Intensive/Lawn Conditions: Gardendrain GR30

J. Filter Fabric

K. Soil
1. Custom growing media mix capable of supporting vigorous growth of the specified vegetation, complying with the following specification. - American Hydrotech, Inc., Shallow-Intensive/Lawn LiteTop® Growing Media

PROPERTY

<table>
<thead>
<tr>
<th>GRAIN SIZE DISTRIBUTION</th>
<th>SHALLOW-INTENSIVE/LAWN*</th>
</tr>
</thead>
<tbody>
<tr>
<td>clay fraction</td>
<td>&lt; 2 %</td>
</tr>
<tr>
<td>passing #200 sieve</td>
<td>3-6 %</td>
</tr>
<tr>
<td>passing #60 sieve</td>
<td>10-30 %</td>
</tr>
<tr>
<td>passing #18 sieve</td>
<td>20-50 %</td>
</tr>
<tr>
<td>passing 1/8-inch sieve</td>
<td>55-95 %</td>
</tr>
<tr>
<td>passing 3/8-inch sieve</td>
<td>90-100 %</td>
</tr>
</tbody>
</table>

DENSITY

| Application Density     | 0.8 - 1.2 g/cm³ |
| Saturated Density       | 1.0 - 1.5 g/cm³ |
| Dry Density             | 0.7 - 1.1 g/cm³ |

WATER & AIR MANAGEMENT (% vol.)
saturated water capacity \(>35\%\)
saturated air content \(>15\%\)

**SATURATED HYDRAULIC CONDUCTIVITY**
\(>1.2\,\text{mm/min}\)
\((>2.8\,\text{in/hr})\)

**pH, LIME, AND SALT CONTENT**
- pH (saturated paste) \(6.0 - 7.5\)
- carbonate content \(<25\,\text{g/l}\)
- salts content (water extract) \(<3.0\,\text{g/l}\)
  \((<2.0\,\text{mmhos/cm})\)

**ORGANICS**
- OM content \(3 - 6\,\text{mass\%}\)
- C/N ratio \(<20\)

**NUTRIANTS** (plant available)
- nitrogen (NO3) \(3 - 15\)
- phosphorus \(1 - 7\)
- potassium \(6 - 15\)
- calcium \(19 - 65\)
- magnesium \(3 - 15\)

**CEC CAPACITY** \(>5\,\text{cmol/kg}\)

Compost Fraction

- Meet or exceed USEPA Class A standard, 40 CFR 503.13, Tables 1 & 3 (chemical contaminants) and 40 CFR 503.32(a) (pathogens) and/or be permitted in the state of origin to produce Class A material.
- Meet US Compost Council STA/TMECC criteria or equal for Class I or II stable, mature product.
- * Values may be adjusted due to availability of local materials or special project conditions related to plant selection and/or environmental conditions.
- ** Nutrients shall be adjusted with appropriate slow-release fertilizer with micronutrient additions if below lower target range.
- Expanded lightweight aggregate for use as fill material for drainage/water retention component as required. – American Hydrotech, Inc., LiteTop® Lightweight Aggregate 3/8” - 3/4” (9.5 - 20 mm) expanded, lightweight aggregate

**PART 3 - EXECUTION**

### 3.1 INSPECTION

A. The roofing contractor shall examine all surfaces to receive the roofing assembly to verify it is acceptable and proper for the application of the membrane. Refer to American Hydrotech’s Pre-Installation & Application Guidelines.

B. The roofing contractor shall not proceed with the installation of the roof membrane assembly until all roof defects have been corrected.

### 3.2 PREPARATION

A. All surfaces must be dry, smooth, free of depressions, voids, protrusions, clean and free of unapproved curing compounds, form release agents and other surface contaminants.
  1. Cast in-place concrete/Composite deck
a. Poured in place concrete must be monolithic, smooth, and free of voids, spalled areas, laitance, honeycombs, and sharp protrusions.
b. Refer to Section 1.02 of this specification, Division 3.

B. Substrate cleaning:
   1. Thoroughly sweep the substrate which is to receive the roof membrane.
   2. Substrate must also be blown clean using an air compressor to remove any remaining loose debris.
   3. Final check to determine if concrete has been properly cleaned is to apply a test patch of Monolithic Membrane 6125® to the surface and check its adhesion.

3.3 INSTALLATION

A. Surface conditioner application (to concrete substrates only)
   1. Apply the surface conditioner only to concrete using a hand held sprayer evenly at a rate of 300 to 600 SF/gallon (7.4 - 14.7 m²/L) depending on surface texture. Surface conditioner shall “tan” the surface, not blacken it.
   2. Allow sufficient time for the surface conditioner to thoroughly dry prior to the membrane application.

B. Membrane preparation
   1. The membrane shall be heated in double jacketed, oil bath or hot air melter with mechanical agitation, specifically designed for the preparation of a rubberized asphalt membrane.
   2. Heat membrane until membrane can be drawn-free flowing at a temperature range between 350°F (176°C) and 375°F (190°C).

C. Detailing/Flashing
   1. All detailing and flashing shall be done in accordance with the manufacturer’s standard guideline details.
   2. All detailing and flashing shall be completed before installing the membrane over the field of the substrate.

D. Membrane Application
   1. Apply the rubberized asphalt membrane at a rate to provide a continuous, monolithic coat of 90 mil minimum (approximately 2.3 mm), into which shall be fully embedded a layer of the spunbonded polyester fabric reinforcing sheet, followed by another continuous monolithic coat of membrane at an average thickness of 125 mil (approx. 3.2 mm). Total membrane thickness shall be 215 mils average (approx. 5.5 mm), 180 mils minimum.
   2. Overlap fabric reinforcing sheet 1-2 inches (25.4 mm - 50.8 mm) with membrane between sheets.

3.4 SEPARATION/PROTECTION COURSE INSTALLATION

A. Separation/Protection course shall be installed as follows: (Edit to project requirements)
   1. Embed the Hydroflex® RB protection/root barrier protection course into the membrane while it is still hot to insure a good bond.
      a. Overlap adjoining sheet edges 4” (100 mm) and seal the laps with a propane torch.

3.5 WATER TEST

A. The roof area or portions thereof shall be leak tested by means of electronic testing or by ponding water at a minimum depth of 2” (50.8 mm) for a period of 48 hours to check the integrity of the membrane installation.
   1. Electronic beach detection testing shall be required prior to the placement of subsequent overburden in the event of excessive damage to the membrane assembly.
   2. VERIFY that the structure can support the deadload weight of a watertest before testing.
B. If leaks should occur the water must be drained completely and the membrane installation repaired.

3.6 GARDEN ROOF® COMPONENTS INSTALLATION

A. Root Barrier Protection.
   1. Where Hydroflex RB was previously installed, no additional root protection shall be required.

B. Insulation. Where specified, STYROFOAM® brand insulation shall be installed loose-laid in accordance with manufacturer's recommendations.

C. Air Layer. When insulation and Moisture Mat are specified an air layer shall be required between the surface of the insulation and the water retention mat. A layer of Hydrodrain® 300 shall be installed over the insulation. The 4 inch (100 mm) salvage edge of the geotextile fabric overlaps adjoining sheets and can be held in place with duct tape. Extend the Hydrodrain 6” into the Gardendrain GR30 medium below the soil to provide a continuous air layer throughout the roof assembly.

D. Drainage/Water Retention Component.
   1. Gardendrain® GR30 shall be installed with holes through the dimples on top, over the root barrier protection, water retention mat (if used) or STYROFOAM® insulation (if used). Adjacent panels may be butt together or overlapped approximately 1 inch (25 mm).
   2. Gardendrain shall be cut to fit around penetrations, etc. with a heavy-duty utility knife or small toothed saw.
   3. The cups of the Gardendrain shall be filled with lightweight aggregate level with the top surface of the panels.

E. Filter Fabric.
   1. A layer of Systemfilter shall be laid over the Gardendrain, lapping adjacent rolls a minimum of 6 inches (150 mm). Enough material shall be left to be drawn up above the anticipated soil level. Any excess shall be trimmed down to the level of the soil.
      a. Filter fabric shall be laid at penetrations, terminations, etc.

3.7 SOIL INSTALLATION

A. LiteTop soil shall be placed carefully to avoid damage or displacement of other materials such as walls, paving, drainage components, filter fabric, and roofing membrane.

B. LiteTop soil shall be placed to within 1 inch greater than final grade or to a depth of no greater than 8 inches and compacted as described in 3.08.C. below. For final grades less than 8 inches only one round of compaction shall be performed and remaining soil loosely placed such that top of soil exceeds final grade by 1 inch (see 3.08.D. below). For final grades greater than 8 inches, place soil at no greater than 6 inches and repeat procedure until soil has been compacted within 1 inch of final grade.

C. Compaction shall be performed with a 200 – 300 lb. landscape roller or lightly compacted with a hand held mechanical compactor to achieve a 50 – 60 % compaction as determined by ASTM D1557.

D. After compaction remaining soil shall be placed at 1 inch greater than final grade and thoroughly watered or jetted over entire area. Low settled areas shall be filled with additional soil and re-wet to achieve uniform prescribed final grade.

3.8 VEGETATION INSTALLATION

A. Supply and install specified Sod Lawn in accordance with Section 32 9200, after Irrigation system is fully operational to ensure lawn maintenance and survival.
SECTION 33 01 01 - MAINTENANCE AND SUPPORT OF EXISTING UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Coordination, maintenance, support, and protection and restoration requirements of existing public and private utilities affected by construction.

B. Existing Utility Facilities: Existing utility facilities include, but are not limited to the following:
   2. UGI – Gas distribution and services.
   5. PPL – Electrical.

C. Related Sections:
   1. Summary of Work: Applicable section of Division 1
   2. Summary of Project: Applicable section of Division 1.
   3. Project Coordination: Applicable section of Division 1.
   4. Regulatory Requirements and Safety: Applicable section of Division 1.
   5. Special Project Procedures: Applicable section of Division 1.
   7. Section 02 41 00: Demolition.
   8. Section 31 20 00: Earth Moving.
   9. Section 31 22 00: Grading.
   10. Section 31 23 33.13: Trenching and Backfilling for Site Utilities.
   11. Section 33 40 00: Storm Drainage Utilities.
   12. Section 33 01 03: Utility Relocation.

1.2 DEFINITIONS

A. Facility: Utility structures and system components belonging to a Utility Company including service lines which are used to provide service to the Utility's customers and the product these facilities convey.

B. Utility: The company, agency, authority, owner, or operator of the facility concerned.

C. Abandoned: The use of existing facilities has been discontinued by the owners and operators.
   1. Demolish or remove these facilities insofar as they conflict with the proposed work.

D. To Be Abandoned: Use of a particular facility will be discontinued after written notice from the appropriate utility company or the Engineer has been received by the Contractor that the service is no longer required.
   1. Perform all work necessary to maintain service for as long as is required, which may include temporary support, rerouting, substitution of temporary facility or other required means. Demolish or remove these facilities insofar as they conflict with the proposed work after a written notification has been received from the owner.
   2. Abandon water and sewer facilities to remain in place only after receipt of a written approval.

E. Maintenance: Providing continuous and satisfactory service during construction.
F. To Be Maintained: The support and maintenance, in serviceable condition, of existing facilities during construction. It may include constructing permanent support, temporary support as indicated on the Contract Drawings, or other means necessary, as directed by the Engineer, to maintain continuous service utilizing the existing facility.

1.3 QUALITY ASSURANCE

A. Codes, Regulations, Reference Standards, and Specifications:
   1. Codes and regulations of the jurisdictional authorities.
   2. Published standards of owning utility agency.

1.4 SUBMITTALS

A. In accordance with applicable Division 1 Specification for Submittals, submit the following:
   1. Shop Drawings and Working Drawings:
      a. Submit working and shop drawings indicating plan and scheduling for performance of work to the appropriate utility for review and approval.
      b. Show actual location of existing facilities, interference which these facilities present to new work, proposed method of proceeding with actual construction and details of proposed support systems. Contractor’s support systems shall be constructed similarly to the detail shown on the Contract Drawings.
      c. Do not commence work until written approval has been received from the Engineer and the affected utilities.
   2. Documentation:
      a. Notice of commencement of work:
         2) Give notice of at least two weeks and as otherwise required by the affected utilities prior to date of intended commencement of operations to parties having surface, subsurface or overhead structures and facilities in the construction area.
         3) Provide copies of notices to the Engineer.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Coordinate with the specified utility companies who are furnishing materials for the work to determine availability, locations, and required methods of storage and care of materials prior to incorporation into the work.

B. Transport, store, and handle materials in accordance with the requirements of the utilities.

1.6 JOB CONDITIONS

A. Location of Facilities:
   1. Make every effort to indicate, properly, all existing utilities.
   2. Prior to start of any work, contact the Pennsylvania One Call System (POCS) at 1-800-242-1776 in order to provide for locating and marking underground facilities.
   3. Locations of existing facilities shown on the Contract Drawings are plotted from available records; however, these locations are not guaranteed.
   4. Verify locations of facilities by field investigation within and adjacent to limits of project which may be affected by construction operations. Avoid damage or disruption of facilities during operation.
   5. Upon encountering existing facility which is not shown or upon ascertaining that facility differs from that shown, determine ownership, use, and disposition of such facility and proceed as follows:
a. If facility is abandoned or is to be abandoned, perform necessary work for either
c condition as shown or specified.
b. If facility is to remain in service, perform support and restoration work in
accordance with these specifications and the Contract Drawings.


B. Coordination with Utilities:
1. Establish direct and continual contact with the following list of Utilities and cooperate with
them in all phases of work. Coordinate Contractor’s work schedule with that of the utility
company’s schedule to perform work on the utility owned facility, so that conflicts and
interruption of work sequence will be prevented.
a. Telecommunications, Water, Sewer, Electric:
   The Pennsylvania State University
   Office of Physical Plant
   Physical Plant Building
   University Park, PA 16802
   Telephone: (814) 865-7194
b. Gas:
   Craig Seibler
   UGI Utilities, Inc.
   1233 Cumberland Street
   Lebanon, PA 17042
2. Contact the Utility allowing sufficient time to accomplish the work they are required to
perform giving special consideration to required lead times. Provide the Utility with the
schedule of utility facility relocation/protection to permit coordination with the sequence of
the work.

C. Responsibilities of Contractor:
1. Maintain and protect facilities.
2. Give notice of commencement of work as specified.
3. Notify the Engineer, Owner, and the utility of damage to facilities caused by construction
operations. Pay for repair of such damage; damaged cables will be repaired or replaced
as determined by the utility with all costs borne by the Contractor.
4. Provide accesses for inspection of facilities and for emergency involving utility services.
5. Permit free and clear access to utility personnel for purposes of inspection, maintenance,
providing additional service and construction of new facilities.
6. Pay utility directly if, as an aid to the Contractor’s construction, the utility performs work
not shown.
7. When approved working or shop drawings show temporary facility provided for the
Contractor’s benefit, supply necessary materials, and perform necessary work.

D. If existing pipe is found to be encased with asbestos material, and the work of this contract does
not involve any modification to this pipe nor does the work involve removal of asbestos material,
proceed as follows:
1. Use a temporary barricade to protect the pipe from contact by contractor’s personnel and
equipment. If there is any disturbance or potential for disturbance of asbestos containing
materials, or there is a potential for fiber release, or if any "asbestos abatement"
operations are initiated, conform to the following regulations:
a. PA Act 194 (63PS§2101, et seq) - Asbestos Occupations Accreditation and
   Certification Act.
b. National Emissions Standard for Hazardous Air Pollutants (NESHAPs) [40 CFR
   Part 61].
d. EPA Standards.
e. PADEP Standards.
PART 2 - PRODUCTS

2.1 MATERIAL

A. Backfill: In accordance with Sections 31 20 00: Earth Moving and 31 23 33.13: Trenching and Backfilling for Site Utilities.

B. Utility Facilities: As specified in other Sections of these specifications and as required by the Utility owner.

PART 3 - EXECUTION

3.1 GENERAL

A. Maintain complete in place continuity of service, provide proper support, and protect utility facilities in accordance with the specifications of the utility affected.

B. Support facilities so as not to expose them to undue vibrations. Support and maintenance of these facilities will be subject to inspection by the utility.

C. Repair or replace public utilities damaged during construction at no cost to Owner, to the satisfaction of the utility.

D. Assume the cost for repair or replacement of private utilities damaged during construction, which will be repaired or replaced by the private utility.

E. Conform to the specifications and standard practices of the affected utility owners. Coordinate with utility owners which work shall be done by Contractor and which work shall be done by the utility owner.

F. Provide, install, and maintain all temporary facilities required to provide interim utility service when a utility facility is to be relocated and when a utility facility to be replaced is abandoned prior to replacement.

3.2 EXCAVATION AND BACKFILLING OF UTILITY TRENCHES

A. Excavate and backfill utility trenches in accordance with Section 31 23 33.13: Trenching and Backfilling for Site Utilities and with the requirements of the affected utility.

B. Proceed with caution in areas of utility facilities; expose them by hand excavation or other methods acceptable to facility owner.

3.3 PAVEMENTS, SIDEWALKS, CURBS, AND GUTTERS

A. Where necessitated by utility trenches and in accordance with Section 02 41 00: Demolition, remove pavements, sidewalks, curbs, gutters, other existing features and those which may interfere with the work and may be directed to be removed by the Engineer.

B. Replace removed pavements, sidewalks, curbs, and gutters, other existing features required to be replaced or directed to be replaced by the Engineer, in accordance with other sections of these specifications.
C. Place temporary pavements where necessitated by sequence of operation.

3.04 UNSAFE AND UNSUITABLE UTILITY STRUCTURES

A. General Requirements:
   1. If, upon exposure, condition or location of facility to be supported in place is found to be unsafe for maintenance or support, contact utility for repair or reconstruction procedures.

B. Electric, Communication, and Similar Type Facilities:
   1. If structures containing electrical, communication and similar types of cables shown to be maintained complete in place are found upon exposure to be incapable of being maintained in place because of condition, location or both, contact utility for repair or reconstruction procedures.
   2. When service box, manhole or conduit structure containing electrical or communication cables is broken away, contact utility for repair or replacement procedures.
   3. Exercise care when working in vicinity of telephone structures containing coaxial cable which cannot withstand movement.

3.05 STORM AND SANITARY FACILITIES

A. Except for disconnects required as work of this contract, maintain service in sewer, house connections, and laterals at all times.

B. Prevent entry into sewers of material which might clog, damage, or otherwise interfere with operation of sewer.

C. See Sections 33 40 00: Storm Drainage Utilities and 33 01 03: Utility Relocation.

3.06 WATER DISTRIBUTION AND SERVICES

A. Except for disconnects required as work of this Contract, ensure continuity of service, except as directed by Owner. Arrange and coordinate such work so as to minimize interruption of service.

B. The Contractor shall make disconnects and perform repair or reconstruction work as needed or indicated and as specified in Section 33 01 03: Utility Relocation.

C. Do not disturb, tamper with, or remove fire hydrants, water meters, meter pits, valves, and appurtenances without proper approval from Owner.

3.07 ELECTRIC TRANSMISSION, DISTRIBUTION, AND SECONDARY FACILITIES

A. Except for disconnects required as work of this Contract, maintain continuity and integrity of existing facilities in accordance with the requirements of the electric power company.

B. If repair or reconstruction work is required due to damage or negligence by the Contractor, the Contractor shall pay the costs associated with the repair or reconstruction of the damaged facility.

3.08 TELECOMMUNICATIONS FACILITIES

A. Except for disconnects required as work of this Contract, maintain continuity of existing communication services of telephone company. Support and protect facilities during construction operations as approved by Owner.
B. With the advance notice specified above, Contractor will make disconnects and will perform repair or reconstruction work of telecommunication facilities at no cost to the Contractor. If repair or reconstruction work is required due to damage or negligence by the Contractor, the Contractor shall pay the costs associated with the repair or reconstruction of the damaged facility.

3.09 GAS DISTRIBUTION AND FACILITIES

A. Maintain continuity of existing gas distribution and services. Support and protect facilities during construction operations.

B. If repair or reconstruction work is required due to damage or negligence by the Contractor, the Contractor shall pay the costs associated with the repair or reconstruction of the damaged facility.

END OF SECTION 33 01 01
SECTION 33 01 03 - UTILITY RELOCATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies the listed utility services which are located near enough to the Project site that construction operations may or will require relocation of the utility as indicated on the Drawings.
   1. Piped Utilities:
      a. Water Service.
      b. Wastewater Sewer Service.
      c. Natural Gas Service.
   2. Electric Service, Conduit, and Cable.
   3. Telephone/Communications Service.
   4. CATV Service.

B. Related Divisions
   1. Electrical: Division 16.

C. Related Sections:
   1. Section 31 23 33.13: Trenching and Backfilling for Site Utilities.
   2. Section 33 05 16.13: Precast Concrete Utility Structures.

1.2 REFERENCES

A. Electrical References: The following codes, standards, and approvals shall serve as the minimum standards and quality requirements directly appropriate to the work and workmanship.
   3. Underwriters' Laboratories, Inc. (UL) Listings, Labels, and Approvals shall govern the quality and performance of certain specified Products.

1.3 SUBMITTALS

A. Shop Drawings and Product Data:
   1. Manufacturer's published detail drawings, modified to suit design conditions if required, and Contractor prepared drawings as applicable.
   2. Manufacturer's descriptive literature and specifications covering the product required. Include installation information.

1.4 QUALITY ASSURANCE

A. Source Quality Control: Use products of companies having established reputations in the manufacture of the particular materials, equipment, or apparatus specified. Such products may be of their own make, or products of others for which they assume full responsibility when used in said outfits (which are not manufactured completely by them), and with replacement parts available.

B. Requirements of Regulatory Agencies:
   1. General Requirement: Comply with construction requirements of State, County, or other political subdivision, which requirements exceed these Specifications.
a. Service interruptions are to be kept to a minimum and are to be at times directed by the Owner of the utility. In order to keep the down time to a minimum, the Contractor shall complete as much of the work as possible prior to the interruption.

2. Certificates and Permits: Upon completion of work, and prior to final payment, furnish formal certification of final inspections to the Engineer from authorities having jurisdiction and secure required permits or certificates (if any) from such authorities. Additionally, prepare detailed diagrams and drawings which may be required by those authorities having jurisdiction.

3. Water Service: Consult the Pennsylvania State University for specific requirements concerning the work of connecting into the public water system and materials and methods to be used for such connection.

4. Wastewater Sewer Service: Consult the Pennsylvania State University for specific requirements concerning the work of connecting into the public sewer system and materials and methods to be used for such connection.

5. Natural Gas Service: Consult UGI Industries, Inc., Gas Division, for specific requirements concerning the work of connecting into the public gas system and materials and methods to be used for such connection.

6. Electric Service: Consult the Pennsylvania State University for specific requirements concerning the work of connecting into the electric system and materials and methods to be used for such connection.

   a. Code Compliance Inspection: Have the work inspected by an authorized inspection agency for compliance with National Electrical Code and obtain certificates of approval, acceptance, and compliance with code regulations. Work shall not be deemed complete until such certificates have been delivered to the Owner.

7. Telephone Service: Consult the Pennsylvania State University for specific requirements concerning the work of connecting into the Telephone system and materials and methods to be used for such connection.

8. CATV Service: Consult the Pennsylvania State University for specific requirements concerning the work of connecting into the CATV system and materials and methods to be used for such connection.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Transport and handle products in a manner recommended by the respective manufacturers of such to prevent damage and defects.

B. Store Products in accordance with manufacturer’s recommendations to avoid shock or prevent physical damage and defects.

1.6 SITE CONDITIONS

A. Environmental Requirements:
   1. Keep trenches dewatered until pipe joints have been made and concrete work, if any, has cured.
   2. Under no circumstances lay pipe (or conduit) in water or on bedding containing frost.
   3. Do not lay pipe (or conduit) when weather conditions are unsuitable, as determined by the Engineer, for pipe (or conduit) laying work.

B. Seasonal Restrictions:
   1. Where seasonal restrictions are not specified in Water Service requirements, restrict work of uncovering and connecting to existing water mains to the time period between May first and October first. This requirement may be waived at the discretion of the Engineer depending on environmental conditions if at the request of the Contractor another time for connection is desired.
C. Protection:
1. Exercise care during utility uncovering and connecting work to confine operations to the facilities as indicated on the Drawings. The physical means and methods used for protection are at the Contractor's option. However, the Contractor will be completely responsible for replacement and restitution work of whatever nature to adjacent structures and construction.
2. Exercise every precaution against flotation of both existing and new pipe (or conduit) and in-line or on-line structures. Correct damage from flotation to the satisfaction of the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide materials and equipment (Products) for incorporation in the work that are new and unused standard products of recognized reputable manufacturers.
1. For each category of Products, provide Products of the same manufacturer and type.
2. Provide Products that match existing materials and are suitable for the type of service required.
3. Use pipe and fittings designed to withstand imposed trench loadings and conditions at the various locations.
4. Flexible Pipe Coupling: Clamped design with virgin PVC coupling and two type #305 stainless steel bands, such as manufactured by Fernco Joint Sealer Co. (Flexible Couplings distributed by the General Engineering Company, Frederick, Maryland).

B. Trenching and Backfilling Materials: Conforming to requirements of Section 31 23 33.13: Trenching and Backfilling for Site Utilities.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect each section or length of pipe (and conduit), and each fitting, before laying for defects that would affect performance.

B. Promptly remove rejected Products from the Project site.

3.2 PREPARATION

A. Field Measurement: The Drawings are in general indicative of the Work with symbols and notations for clarity. However, the Drawings are not an exact representation of all conditions involved, therefore, layout piping to suit actual field measurements.
1. Submit details of proposed departures necessitated by field conditions or other causes to Engineer for approval.
2. No extra compensation will be made for Work due to differences between indicated and actual dimensions.

B. Earthwork: Perform earthwork for buried piping (and conduit) as specified in Section 31 23 33.13: Trenching and Backfilling for Site Utilities.
1. Rest each section of pipe on pipe bedding for the full length of its barrel, with recesses excavated for pipe joints so joints can easily be made.
2. Backfill recesses with bedding material immediately following pipe joining operations.

3.3 RELOCATION

A. General Requirements: Construct piping (and conduit) from full lengths of pipe (and conduit) using short sections only for runs of less than full pipe (and conduit) length. Use reducing fittings where reduction in pipe sizes is necessary. Bushings will not be accepted.
1. Use only the proper and suitable tools and apparatus for proper and safe handling, lowering into trench and laying of pipes (and conduit).
2. Clean piping (and conduit) interior prior to installation and following installation. Keep open ends of piping (and conduit) attachment openings on equipment capped or plugged until actual connection.
3. Take up and relay pipe that is not laid true to required alignment or grade or has its joints disturbed after laying. No deviation from the required line and grade permitted, except with approval of the Engineer.
4. Pipe Joining: Exercise care when making the pipe joints and make joints in accordance with the pipe material manufacturer’s recommendations and the following requirements. In each instance of pipe joining, those portions of pipes involved must be absolutely clean just prior to assembly. If a joint is extremely difficult to assemble or sealing is not affected, disassemble the joint and correct the difficulty if possible. Remake the joint using new materials when necessary.

B. Water Service Pipe Relocation: Unless indicated otherwise, install piping with not less than four feet of cover.
1. Reaction or Thrust-backing: Stall reaction or thrust backing, or restrained joints on buried DIP at changes in direction of pipe runs.
   a. Use 3,000 pounds (Class B) concrete placed between solid undisturbed ground and fitting to be anchored. Perform concrete work as specified in Section 03 30 53: Miscellaneous Cast-in-Place Concrete.
   b. Minimum area bearing on pipe and on ground as indicated on Drawings.
2. Joint Restraints: Install on buried DIP at changes in direction of pipe runs, and at terminal ends of pipe runs in accordance with the following table:

   DUCTILE IRON PIPE RESTRAINED JOINT DIMENSIONS
   (In feet of straight pipe for each leg)

<table>
<thead>
<tr>
<th>Fitting</th>
<th>6 In. Dia. Pipe</th>
<th>8 In. Dia. Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plug</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Tee</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Lateral</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>90 degrees</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>45 degrees</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>22 1/2 degrees</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>11 1/4 degrees</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

3. Setting Valves, Stops, and Boxes:
   a. Unless otherwise directed by the Engineer, set valves, curb stops and boxes truly vertical.
   b. Set valve and curb stop boxes neatly to grade and in such a way that the box does not transfer shock or stress to the valve or stop. Exercise care to center the box over the wrench nut of the valve or stop.
4. **Connection of Relocated Main to Existing Water Main:** Make connection in conformance with Water Service utility requirements exercising necessary precaution to prevent contamination to the existing main.

C. **Wastewater Sewer Service Pipe Relocation:** Lay pipe proceeding upgrade true to line and grades indicated. Lay bell and spigot pipe with bell end upgrade. Lay tongue and groove pipe with groove end upgrade.
   1. No wedging or blocking permitted in laying pipe unless by written order of Engineer.
   2. Where necessary to field cut pipe use approved pipe cutter, milling cutter, or abrasive wheel saw.
   3. Before joints are made, bed each section of pipe full length of barrel with recesses excavated so pipe invert forms continuous grade with invert of pipe previously laid. Exercise care to insure that each length abuts against the next in such manner that no shoulder or unevenness of any kind occurs along inside bottom half of pipe line. Do not bring succeeding pipe into position until the preceding length is embedded and securely in place.
   4. Walking or working on completed pipe line, except as necessary in tamping and backfilling, not permitted until trench is backfilled one-foot deep over top of pipes.

5. **Connections of Pipes to New Manholes:** As specified in Section 33 49 00: Storm Drainage Structures.

6. **Connections of Pipes to Existing Manholes:** In the case where the Wastewater Service utility has no requirements concerning such connections, make connections as follows:
   a. Cut required pipe opening by such methods so as to prevent cracking and spalling of manhole material.
   b. Make opening of sufficient size to accommodate the pipe with an installed PVC Waterstop and one (1) inch of annular grout space.
   c. PVC Waterstop of gasket design and composed of virgin polyvinyl chloride (PVC); similar to CMA Concrete Manhole Adapter by Fernco Joint Sealer Co. (distributed by The General Engineering Co., Frederick, Maryland), or equal.
   e. Form a new invert channel in the existing manhole base to properly conduct the flow through the existing manhole.

7. **Drop Connections:** In the case where a drop connection is required, make such connection as indicated on the Drawings.
   a. Use the same pipe material to construct the drop connection as is used to construct the wastewater building sewer of this Contract.

8. **Connection of Relocated Piping to Existing Piping:**
   a. When existing piping ends in a bell, remove the bell by cutting with a mechanical saw. Removing the bell or other pipe sections by hammering or chiseling is not permitted.
   b. Make connection of relocated piping to existing piping using Flexible Pipe Couplings. Provide reducing Flexible Pipe Coupling where required to accommodate differing pipe material.

D. **Natural Gas Service Pipe Relocation:** In general, install gas piping in accordance with requirements of NFPA 54 (National Fuel Gas Code) and the Natural Gas Service utility requirements exceeding NFPA.
   1. Following gas piping installation, and prior to concealing gas piping in any manner, conduct a test of the protective coating on both pipe and fittings using an approved type Holiday detector. Make repairs, if any, using the appropriate materials consistent with those provided on pipe and fittings. Repeat tests on such repairs.

E. **Underground Conduit System Relocation:** Install underground conduit systems in accordance with Article 300-5 of the NEC and the applicable Division 16 specification section.
3.4 FIELD QUALITY CONTROL

A. General Requirements: Conduct tests specified herein so that each pipe line installed in the Project is tested. Conduct tests of every kind in the presence of and to the satisfaction of the Engineer.

1. Equipment: Provide tools, materials (including water), apparatus, and instruments necessary for pipe line testing.
2. Repair and Retest: When a pipe line fails to meet test requirements specified herein, conform to the following:
   a. Determine source or sources of leakage.
   b. Repair or replace defective material, and if a result of improper workmanship, correct such.
   c. Conduct additional tests to demonstrate that pipe line meets specified test requirements.
3. Accuracy Proof: Furnish acceptable proof to the Engineer that testing apparatus, pressure gauges, etc. have been recently checked and calibrated as applicable prior to use on this Project.
4. Notification: Give the Engineer a minimum of three days advance notice of the times when pipe line acceptance testing will be conducted.

B. Water Service Pipe Line Testing and Disinfecting: Conduct testing and disinfecting in accordance with the Pennsylvania State University requirements, or in accordance with the following requirements, whichever is more stringent.

1. Prior to testing, allow those installed sections of water piping protected by concrete reaction blocking to stand undisturbed for at least seven days from concrete pour. Provide temporary blocking as required.
2. The Contractor may, at his option, completely backfill the trench or partially backfill the trench over the center section of each pipe length prior to performing the pressure test.
3. Fill the section of installed water piping being tested with water a minimum of twenty-four hours prior to testing. During filling insure the piping is free of air. Use potable water for filling.
4. Line Acceptance Test: After the water line is constructed, backfilled (as stated above), and successfully cleaned, perform a hydrostatic line acceptance test as follows:
   a. Seal water line at downstream end with a suitable pipe plug.
   b. Fill water line with potable water (as stated above).
   c. Raise hydrostatic pressure to 150 psi.
   d. Maintain test pressure for a period of not less than one hour.
   e. Also conduct a leakage test for a duration of two uninterrupted hours at the same pressure specified for the hydrostatic test and provide a means for measuring leakage. Piping being tested will not be accepted if leakage is greater than that determined by the formula $L = ND P$ in 7400 which L is the allowable leakage in gallons per hour; N is the number of joints in the length of pipeline tested; D is the nominal diameter of the pipe in inches; and P is the average test pressure in pounds per square inch (based on test pressure indicated above, measured at the low point).
   f. The leakage test may be conducted simultaneously with the pressure test, provided a suitable means of measuring leakage is provided and a record of water added to the piping being tested is kept for the two hour test period.
5. Disinfection of Water Line: Disinfect the pipe and connections installed as follows:
   a. Observe every precaution during the installation of the connection to prevent foreign material and trench water from entering the pipe and fittings during their installation.
   b. Swab the interior of pipe and fittings with a five percent hypochlorite solution. A five percent hypochlorite solution can be obtained by mixing approximately three pounds of granulated calcium hypochlorite with five gallons of water.
c. After the pipe, fittings, and valves have been swabbed, then thoroughly flush with potable water.

C. Wastewater Sewer Service Pipe Line Testing: Conduct testing in accordance with the Pennsylvania State University requirements, or in accordance with the following requirements, whichever is more stringent.
   1. Partially backfill the trench over the center section of each pipe length prior to performing line acceptance test.
   2. Line Acceptance Test: After the sewer line is constructed, backfilled (as stated above), and successfully cleaned, perform a hydrostatic head line acceptance test as follows:
      a. Seal sewer line by insertion of a test plug at point of connection with the public sewer and fill sewer line with water.
      b. Apply a head of water of not less than ten feet and maintain head for a period of not less than fifteen minutes, and longer as required to inspect each pipe joint in the sewer line.
      c. A test will be considered successful when the head of water is maintained unaided for fifteen minutes continuously and every joint in the sewer line is proven leak free.

D. Natural Gas Service Pipe Line Testing: Conduct testing in accordance with UGI service requirements, or in accordance with the following requirements, whichever is more stringent:
   1. The Contractor may, at his option, completely backfill the trench or partially backfill the trench over the center section of each pipe length prior to performing line acceptance test.
   2. Line Acceptance Test: After the natural gas line is constructed, backfilled (as stated above), and successfully cleaned, perform a pressure test as follows:
      a. Isolate gas line from the main gas line and the metering. Does not included regulation, which must be leak tested separately.
      b. Apply a pressure of at least six inches mercury or three pounds gauge.
      c. Maintain pressure for a period of not less than ten minutes and longer as required to inspect each pipe joint in the gas line.
      d. A test will be considered successful when the pressure is maintained for ten minutes continuously with the source of pressure isolated or disconnected. Measure pressure with a mercury manometer or slope gauge or an equivalent device so calibrated as to be read in increments of not greater than one-tenth (1/10) pound.

E. Electrical Service Testing: Perform testing in accordance with applicable Division 16 specification section.

END OF SECTION 33 01 03
SECTION 33 05 16.13 - PRECAST CONCRETE UTILITY STRUCTURES

PART 1 - GENERAL

1.1  STIPULATION

A. The specifications sections “General Conditions”, “Special Requirements,” and “General Requirements” form a part of this section by reference thereto and shall have the same force and effect as if printed herewith in full.

1.2  SUMMARY

A. Section Includes:
   1. Concrete rectangular manholes (cast in place and precast concrete utility structures) for Mechanical work.
   2. Precast concrete rectangular manholes (precast concrete utility structures) for Electrical and Telecommunication work.
   3. Concrete trenches and utility tunnel for steam, condensate, and compressed air piping.
   4. Concrete pipe anchors for Mechanical work.

B. Related Sections:
   1. Section 31 23 33.13: Trenching and Backfilling for Site Utilities.
   2. Mechanical Insulation: Applicable Division 17 specification.
   3. Section 33 49 00: Storm Drainage Structures.
   4. Section 03 30 53: Miscellaneous Cast-In-Place Concrete.
   5. Section 03 60 00: Grouting.

1.3  REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM A 185, Specification for Welded Steel Wire Fabric for Concrete Reinforcement.
   2. ASTM A 615, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   3. ASTM C 31, Methods of Making and Curing Concrete Test Specimens in the Field.
   4. ASTM C 32, Specification for Sewer and Manhole Brick (Made from Clay or Shale).
   5. ASTM C 33, Specification for Concrete Aggregates.
   7. ASTM C 144, Specification for Aggregate for Masonry Mortar.
  11. ASTM C 309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
  15. ASTM D 624 - Rubber Property - Tear Resistance.
  17. ASTM D 1004 - Initial Tear Resistance of Plastic Film and Sheeting.
  18. ASTM D 2240 - Rubber Property - Durometer Hardness.
20. **ASTM E 96 - Water Vapor Transmission of Materials.**

**B. American Association of State Highway and Transportation Officials (AASHTO) Standards as referenced throughout these Specifications.**

**C. American Concrete Institute (ACI):**
1. ACI 304, Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
2. ACI 308, Standard Practice for Curing Concrete.
3. ACI 309, Guide for Consolidation of Concrete.
4. ACI 318, Building Code Requirements for Reinforced Concrete.

**D. Federal Specifications:**

**1.4 SUBMITTALS**

**A. Shop Drawings and Product Data:** Submit product manufacturer's published detail drawings, modified to suit design conditions if required, and Contractor prepared drawings as applicable, for each product specified herein. Drawings shall indicate the following as minimum requirements:
1. Precast concrete unit dimensions; interior, exterior, and thickness.
2. Details of reinforcing, inserts, anchors, connections, accessories, joints and openings.
3. Precast concrete unit installation and setting details based on manufacturer’s shop drawings and the Professional’s Drawings.

**B. Submit manufacturer's descriptive literature and specifications covering the product specified. Include installation information.**

**C. Certificates:** Submit certified records or reports of results of shop tests, such records or reports to contain a sworn statement that shop tests have been made as specified.
1. Manufacturer's sworn certification that components and products will be manufactured in accordance with specified reference standards for components and products.
2. Manufacturer's sworn certification that the materials used are in compliance with the specified requirements.
3. Manufacturer's sworn certification that manhole frame and cover tensile test bars were poured from the same iron as castings they represent.

**1.5 QUALITY ASSURANCE**

**A. Source Quality Control; Manhole Frames and Covers:** As specified in Section 33 49 00: Storm Drainage Structures.

**B. Precast Concrete Producer Qualifications:** Provide documentation from the precast concrete unit producer that their products have been in continuous service for five years minimum.

**C. Design Criteria:** Provide documentation that the precast concrete utility structures are designed to meet the minimum structural loading requirements of AASHTO HS20-44, ACI 318, and the loads exceeding AASHTO and ACI requirements as may be indicated on the Drawings.

**D. Design Criteria shall include documentation that the structure units have negative buoyancy when subjected to the 100-year flood condition indicated on the Drawings.**
1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Handling: Transport and handle precast concrete units and their associated components, and other products specified herein, in a manner recommended by their respective manufacturers to prevent damage and defects of whatever nature.

B. Through-wall lifting holes are not permitted in structure component construction.

C. Storage: Store precast concrete structure components in accordance with their manufacturer's recommendations to prevent joint damage and joint contamination. Exercise such care in storage of other specified products as recommended by their respective manufacturers.

PART 2 - PRODUCTS

2.1 BASIC MATERIALS

A. Acceptable Manufacturers:
   1. A.C. Miller Concrete Products, Inc.
   2. Penn-Cast Products, Inc.

B. Aggregate Materials: Conforming to ASTM C 33. Both fine and coarse aggregates shall be free of deleterious substances which cause reactivity with oxidized hydrogen sulfide.

C. Reinforcing: Bars conforming to ASTM A 615 Grade 60, and wire fabric conforming to ASTM A 185.

D. Cast-In-Place Concrete Products: As specified in Section 03 30 53: Miscellaneous Cast-in-Place Concrete.

E. Non-Shrink Non-Metallic Grout: As specified in Section 03 60 00: Grouting.

F. Masonry Products: Provide the following products to field form the required adjustment to grade of the cast iron manhole frame and covers:

G. Waterproofed Mortar: Conforming to requirements of ASTM C 270 for Type M, 2500 psi. Parts by volume include: One part cement, 1/4 part lime, and sand at not less than 2-1/4 nor more than three times the sum of the volumes of cement and lime used and of the following materials:

H. Waterproofing Agent: Medusa Waterproofing Powder by Medusa Portland Cement Co.; Hydratite by Grace Construction Materials; or Hydrolox by Chem-Master Corp. Add the Medusa product in the ratio of two pounds per bag of cement; add the other products per manufacturer's recommendations.

I. Portland Cement: Conforming to ASTM C 150, Type I.

J. Hydrated Lime: Conforming to ASTM C 207, Type S.

K. Sand: Conforming to ASTM C 144.

L. Water: Clean and free from deleterious amounts of acids, alkalis, and organic materials.

M. Drainage Structure Brick: Masonry units made from clay or shale conforming to physical and dimensional requirements of ASTM C 32, Grade MS.
N. Preformed Plastic Sealing Compound: Use for section-to-section precast component joint sealing. Provide product conforming to Fed. Spec. SS-S-210A, Type 1, Rope Form, of either bitumastic base compound or butyl rubber base compound, and shipped protected in a removable two-piece wrapper.
   1. Dimensions: Size the cross-section of rope form to provide squeeze-out of material around entire interior and exterior circumference of each structure section joint when joint is completed.
   2. Acceptable Manufacturers:
      a. K.T. Snyder Company, Inc.; RAM-NEK.
      b. K.T. Snyder Company, Inc.; RUB'R-NEK.
      c. Hamilton Kent Manufacturing Company; KENT-SEAL No. 2.

O. Waterstop (Expanding-Type) Sealant: The pipe and conduit seal to be used with multiple pipe groupings and duct banks shall be a specially formulated joint waterstop sealant which swells on contact with water. The waterstop sealant shall be sized small enough so as not to expand the Non-Shrink Non-Metallic Grout fill material out of the pipe or conduit opening.
   1. Adhesive Binder: Install the waterstop on prepared pipelines or conduits entering manholes using the waterstop manufacturer's standard adhesive binder.
   2. Acceptable Manufacturers:
      a. Greenstreak; Hydrotite VCJ.

P. Waterstop (Mastic type, self sealing): Single component self-sealing mastic waterstop, plus primer.
   1. Acceptable Manufacturers:
      a. Greenstreak; Lockstop

Q. Waterproof Coating: Provide asphalt compound coating of either the solvent type or the emulsion type. However, mixtures of the two types in the Project are not permitted.
   1. Solvent Type: Brush or spray-on asphalt compound, cold-applied and conforming to Federal Specification SS-A-701 B.
   2. Emulsion-Type: Brush or spray-on asphalt-base, clay emulsion with fibers, cold-applied and conforming to Federal Specification SS-R-1781.
   3. Acceptable Manufacturers:
      a. W. R. Meadows, Inc.; SEALMASTIC.
      b. Cooper Creek.
      c. Or equal.
   4. Application: The coating may be either factory or field applied. Apply coating to the exterior of the structure components.
      a. Apply coating in two coats at the rate of 75 to 100 square feet per gallon per coat. Allow 24 hours drying between coats.

R. Insulation for Mechanical Work: As specified in applicable Division 17 specification section.

2.2 REINFORCED CONCRETE PIPE

A. Reinforced Concrete Pipe: ASTM C 76, Class II or higher, with Wall Type B; wire reinforcement; inside nominal diameter of 96 inches.

B. Fittings: Reinforced concrete.

C. Joints: ASTM C 443, rubber compression gasket.

2.3 SHEET MEMBRANE WATERPROOFING

A. Manufacturers
1. Polyken - Product 660.

B. Membrane Materials
2. Membrane: 60 mils thick; 36 in. wide roll; conforming to the following criteria:
3. Properties Test Results
4. Tensile Strength: ASTM D 412 500 min.
5. Elongation: ASTM D 412 300 min.
6. Water Absorption: ASTM D 5710 .12% by weight
7. Moisture Vapor: ASTM E 96 0.8 perms
8. Seaming Materials: As recommended by membrane manufacturer.

C. Adhesive Materials
1. Surface Conditioner: As recommended by membrane manufacturer.
2. Adhesives: As recommended by membrane manufacturer.
3. Thinner and Cleaner: As recommended by adhesive manufacturer, compatible with sheet membrane.

D. Attachment Materials
1. Reglet Strip Devices: See Section 03 30 53: Miscellaneous Cast-In-Place Concrete.
2. Sealant: As recommended by membrane manufacturer.

2.4 MANUFACTURED UNITS

A. Fiberglass Ladders: Provide vertical ladders designed and fabricated to comply with OSHA rules and regulations.
1. Material: Pultruded from heavily inlaid glass utilizing a synthetic veil for maximum chemical and ultraviolet resistance.
2. Minimum Glass Content: 50 percent, comprising both longitudinal strands and continuous strand mat so aligned as to provide both longitudinal and transverse strength and prevent splitting due to laminar shear.
3. Fire Retardance: FRP shapes shall have Class I fire retardance, with an ASTM E 84 flame-spread rating of 25 maximum.
5. Acceptable Manufacturers:
   a. Swager Communications Corp. Inc.
   b. IMCO Reinforced Plastic Inc.

B. Manhole Covers and Frames: ASTM A 48, Class 30B Cast iron construction, machined flat bearing surface, removable bolted watertight lid, closed lid design.
1. Provide sizes indicated on drawings manufactured by Neenah Foundry Company.

C. Manhole Steps: Ductile Iron rungs; formed integral with manhole sections.

D. Pipe and Conduit Seals: The Contractor shall have the option to provide the following types of pipe seals unless indicated otherwise on the Drawings:
1. Prefabricated Seals: Sleeve type design pipe seal designed to be cast integrally in the casting process of the precast concrete structure base or wall section. In general, the pipe seal shall conform to the requirements of ASTM C 923, and shall incorporate a positive compression fit gasket designed to seal around the pipe or conduit.
2. Sleeve Type Seal: Sleeve type pipe or conduit seal used for core-drilled connection of piping or conduit to structures. In general, the seal shall conform to the requirements of ASTM C 923 and shall incorporate a positive compression fit of the gasket to both the core-drilled opening and the pipe or conduit.
3. Acceptable Manufacturers:
   a. Press-Seal Gasket Corp., Concrete Products Supply Co.; PSX Seal.
4. Link-Seal (Modular, Mechanical Type): Modular, mechanical type seal used for core-drilled or precast openings. Seal component construction as follows:
   a. The seal shall consist of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.
   b. The elastomeric element of the seal shall be sized and selected in accordance with the seal manufacturer's recommendations. Elastomeric element shall conform to ASTM D 2000 requirements for EPDM material.
   c. The hardware provided in the seal shall be as recommended by the seal manufacturer for buried service such as will exist at the project site.
   d. Acceptable Manufacturers:
      1) Thunderline Corporation; Link-Seal.

2.5 PRECAST CONCRETE COMPONENTS

A. Manufacturers:
   1. A.C. Miller Concrete Products, Inc.
   2. Penn-Cast Products, Inc.

B. Materials and Fabrication: Provide steel reinforced precast concrete structure of either one piece construction, or component construction, conforming to the following:
   1. Forming: Use form of sufficient design and bracing to maintain alignment and prevent deforming under pressure during pouring and vibrating of concrete.
   2. Reinforcing: Bars conforming to ASTM A 615 Grade 60, and wire fabric conforming to ASTM A 185.
   3. Concrete: Composed of Portland cement conforming to ASTM C 150, Type 1 and aggregate conforming to ASTM C 33. Both fine and coarse aggregates shall be free of deleterious substances which cause reactivity with oxidized hydrogen sulfide. Materials shall be accurately weighed at a certified central batching facility prior to mixing. Concrete mixture shall contain cement content in amounts adequate to produce a minimum strength of 5,000 psi concrete at 28 days.
      a. The concrete strengths shall be as confirmed by cylinder strength tests in accordance with ASTM C 31 and C 39.
   4. Placing: Pour concrete in a continuous operation, without segregation or loss in ingredients, until completion of unit; all in accordance with ACI 304. Consolidate concrete by mechanical internal vibrating equipment.
   5. Curing: In general, perform concrete curing by water curing, sheet form curing, or sealing methods; all in accordance with ACI 308.
      a. If steam curing is used, cure units in forms after initial set at temperatures not to exceed 160 degrees F with temperature rise above ambient not to exceed 40 degrees F per hour.
      b. After steam curing and form stripping continue curing by water spray or liquid membrane curing using compounds conforming to ASTM C 309.
   6. Dimensions:
      a. Side Walls: Unit dimensions as indicated on Drawings and formed with pipe opening provisions.
      b. Removable Top: Top dimensions as indicated on Drawings with openings sized to accommodate manhole frame and cover.

C. Precast Base, Wall, and Top Sections: Designs as indicated on the Drawings, materials, and construction as specified previously under Materials and Fabrication.
   1. Removable Top Section: Top section of flat slab design, dimensions as indicated on Drawings. The access hatch shall be either field installed or factory installed integral with the top section during the casting process.
2. Base and Wall Sections: The base and wall sections shall be cast as a single unit except where the base section is required to be separate for installation purposes. Where the depth of the structure exceeds the limitation of single unit construction, provide the appropriately sized riser sections to meet proposed grade.

D. Waterproof Coating: Of materials as specified previously, and either shop or field applied to the precast concrete components.
   1. Apply coating in two coats at the rate of 75 to 100 square feet per gallon per coat. Allow 24 hours drying time between coats.

PART 3 - EXECUTION

3.1 PREPARATION

A. Earthwork: Perform earthwork for precast concrete utility structures installation as previously specified in 31 23 33.13: Trenching and Backfilling for Site Utilities and according to the following:
   1. Protection: During earthwork operations, keep pipe or conduit and structure interiors cleared of debris as construction progresses.
   2. Excavation Limits: Make excavations for the structures to a nearly vertical plane beginning at bottom of excavation one-foot beyond structure footer to two-feet beyond top of the structure.
      a. The excavation limits specified herein are based on allowable payment quantities in the Project.
      b. Backfill spaces outside structures using material as specified in Section 31 23 33.13: Trenching and Backfilling for Site Utilities.
      c. If surface pavement of any type is encountered (vehicle or pedestrian ways), cut such pavement to a rectangular shape. Make limits of cut not to exceed one-foot beyond top-of-excavation limit as specified previously.
      d. No additional compensation allowed should excavation limits or surface pavement cut limit be exceeded. Additionally, should bottom-of-excavation limit be exceeded, provide at no increase in Contract Price, concrete cradle or encasement for pipes or conduits entering or leaving the structure.

3.2 CONSTRUCTION METHODS

A. Cast-In-Place Concrete Construction: Construct in accordance with design and dimensions indicated on Drawings.
   1. Concrete Work: Form, reinforce and pour concrete in accordance with requirements of Division 3 - Concrete.
      a. Use Class A (4000 psi) concrete as specified in Section 03 30 53: Miscellaneous Cast-In-Place Concrete, unless indicated otherwise on Drawings.

B. Precast Concrete Utility Structures Installation: Unless indicated otherwise, install structures on a six inch deep compacted layer of Aggregate Backfill or Foundation Backfill as selected by the Professional in the field.
   1. Section Seals Installation: Install Preformed Plastic Sealing Compound between sections (if any), and to seal the top section on the structure (if any). Install sealing compound in accordance with manufacturer's recommendations and the following:
   2. Prime joint surfaces if required by sealing compound manufacturer.
   3. If sealing compound is installed in advance structure component joining, leave exposed half of two piece protective wrapper in place until just prior to section joining.
4. Use sealing compound as the sole element utilized in sealing structure component joints from internal and external hydrostatic pressure.

5. Arrange and pay for the sealing compound manufacturer's representative to be present for first installation of the compound to instruct workmen on proper installation methods of sealing compound and to be present while structure components are being installed.

6. Following structure component installation, trowel sealing compound surface smooth and flush with interior face of structure.

C. Individual Pipe or Conduit Seals in Structures: The Contractor is allowed the option to seal individual pipes or conduits entering the Structure with Prefabricated Seals, Sleeve Type Seals, or Link-Seals. Install the Pipe or Conduit Seals in accordance with the manufacturer's installation instructions.

1. Set pipe or conduit in the seal so that an equal annular space is created on the interior and exterior of the wall of the manhole base section.

2. Following pipe or conduit installation through the seal, grout the annular space at the pipe connection, on both sides of the wall, to the spring line of the pipe. Finish the grout smooth and flush with face of manhole.

D. Multiple Pipe Groupings and Conduit Banks Seals in Structures: Seal multiple pipe groupings and conduit banks into the structure using Non-Shrink Non-Metallic Grout fill and Waterstop (Expanding Type) Sealant. Install the waterstop material to be centered within the wall thickness of the structure.

E. Waterstop Installation: Install the Surface (Expanding Type) Waterstop on the pipes or conduit bank and in accordance with manufacturer's recommendations and the following:

1. Install the waterstop on properly prepared substrates and in accordance with the environmental requirements stated in the manufacturer's instructions.

2. Under no circumstances shall the waterstop material be allowed to become wet prior to the grout installation.

3. Grout Filling the Annular Space: Install Non-Shrink Non-Metallic Grout to fill the annular space between the pipes or conduit bank and the structure. Trowel the finished grout installation smooth and flush with the structure surfaces, both inside and outside.

4. General requirements for Non-Shrink Non-Metallic Grout installation as specified in Section 03 60 00: Grouting.

F. Cast Iron Manhole Frame and Cover Installation: As specified in Section 33 49 00: Storm Drainage Structures.

G. Piping and Equipment Installation: For piping and equipment installation, see other applicable Specifications Sections of the Project Manual.

3.3 INSTALLATION OF MEMBRANE WATERPROOFING

A. Examination

1. Verify substrate surfaces are durable; free of matter detrimental to adhesion or application of waterproofing system.

2. Verify items which penetrate surfaces to receive waterproofing are securely installed.

B. Preparation

1. Protect adjacent surfaces not designated to receive waterproofing.

2. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions. Vacuum substrate clean.

3. Do not apply waterproofing to surfaces unacceptable to manufacturer or applicator.

4. Seal cracks and joints with sealant materials using depth to width ratio as recommended by sealant manufacturer.
5. Apply surface conditioner at a rate recommended by manufacturer. Protect conditioner from rain or frost until dry.

C. Installation
1. Install membrane waterproofing in accordance with manufacturer’s instructions.
3. Remove release paper layer. Roll out on substrate with a mechanical roller to encourage full contact bond.
4. Lap sides and ends in accordance with membrane manufacturer’s instructions.
5. Overlap edges and ends and seal with contact adhesive, minimum 6 in. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.
6. Reinforce membrane with multiple thickness of membrane material over joints, whether joints are static or moving.
7. Weather lap joints on sloped substrate in direction of drainage. Seal joints and seams.
8. Install flexible flashings. Seal watertight to membrane.
9. Seal membrane and flashings to adjoining surfaces.
10. Extend membrane minimum of 6 in. onto vertical surfaces.
11. Seal items penetrating membrane and install counter flashing membrane material.

D. Protection of Finished Work
1. Protect finished work.
2. Do not permit traffic over unprotected or uncovered membrane.

END OF SECTION 33 05 16.13
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SECTION 33 11 13 - WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The work specified in this Section consists of construction of the on-site private water system pipelines and appurtenances.

B. Related Sections:
   1. Section 31 23 3 - Trenching, Backfilling and Compaction.
   2. Section 03 30 53 - Cast-In-Place Concrete.

1.2 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI A21.10, Gray-Iron and Ductile-Iron Fittings, 3 inch through 48 inch, for Water and Other Liquids.
   4. ANSI A21.51, Ductile-Iron, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
   5. ANSI A21.53, Ductile-Iron Compact Fittings, 3 In. Through 24 In. (76 mm Through 610 mm) and 54 In. Through 64 In. (1,400 mm Through 1,600 mm) for Water Service.

B. American Society for Testing and Materials (ASTM):

C. American Water Works Association (AWWA):
   2. AWWA C105, Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.
   3. AWWA C110, Gray-Iron and Ductile-Iron Fittings, 3 inch through 48 inch, for Water and Other Liquids.
   5. AWWA C150, Thickness Design of Ductile-Iron Pipe.
   6. AWWA C151, Ductile-Iron Pipe Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
   7. AWWA C153, Ductile-Iron Compact Fittings, 3 In. Through 24 In. (76 mm Through 610 mm) and 54 In. Through 64 In. (1,400 mm Through 1,600 mm) for Water Service.
   8. AWWA C502, Dry-Barrel Fire Hydrants.
   9. AWWA C509, Resilient-Seated Gate Valves, 3 inch through 12 inch NPS - for Water and Sewage Systems.
   10. AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.

1.3 SUBMITTALS
A. Shop Drawings and Product Data: Submit Shop Drawings, Catalog Cuts, or other data for products furnished in this Section.

B. Certificates: Certified records or reports of results of shop tests to contain a sworn statement that shop tests were made as specified.
   1. Manufacturer's affidavit stating that products furnished comply with applicable provisions of referenced standards and modifications described in this Section.

1.4 QUALITY ASSURANCE

A. Ductile Iron Pipe: Test in accordance with AWWA C151 (ANSI A21.51).

B. Fittings: Test gray-iron and ductile-iron fittings in accordance with AWWA C110 (ANSI A21.10) and AWWA C153 (ANSI A21.53) Compact Fittings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Transport, handle and store pipe materials, and other specified products, as recommended by respective manufacturers and supplemented in this Section, to prevent damage and defects.

1.6 PROJECT CONDITIONS

A. Inspection: Items of material furnished under this Section will be inspected prior to installation.

B. Environmental Requirements:
   1. Keep trenches dewatered while installing pipe until required pipe joints are made and trench backfilled above water table.
   2. Under no circumstances lay pipe in water or on bedding containing frost.
   3. Do not lay pipe when weather conditions are unsuitable, as determined by Architect, for pipe laying work.

PART 2 - PRODUCTS

2.1 MATERIALS

   1. Wall Thickness: Determined in accordance with AWWA C150 (ANSI A21.50), latest edition. Minimum wall thickness as follows:

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Wall Thickness</th>
<th>Thickness Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inches</td>
<td>Inches</td>
<td>Designation</td>
</tr>
<tr>
<td>4</td>
<td>0.29</td>
<td>52</td>
</tr>
<tr>
<td>6</td>
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<td>52</td>
</tr>
<tr>
<td>12</td>
<td>0.37</td>
<td>52</td>
</tr>
</tbody>
</table>

2. Joints: Provide push-on, mechanical, or restrained joints for pipe installed underground.
a. Push-on and mechanical joints to conform to applicable provisions of AWWA C111.

3. Pipe Lining: Cement mortar lined in accordance with AWWA C104, double thickness, and asphaltic seal coated in accordance with Section 4-11, Seal Coat, of AWWA C104. Provide NSF 61 approved seal coatings.

4. Outside Pipe Coatings: Asphaltic coating in accordance with Section 51-8, Coatings and Linings, AWWA C151.

5. Acceptable Manufacturers:
   a. U.S. Pipe.
   b. American.
   c. Clow.
   d. Griffin.
   e. Atlantic States.
   f. Or equal.

B. Fittings: Gray iron or ductile iron conforming with applicable provisions of AWWA C110 or ductile iron compact fittings conforming to AWWA C153; minimum working pressure rated at 250 psi.
   1. Fittings to be mechanical or restrained joint conforming with applicable provisions of AWWA C111.
   2. Fitting Lining: Cement mortar lined in accordance with AWWA C104, double thickness, and bituminous seal coated in accordance with Section 4-12, Seal Coat, of AWWA C104. Seal coatings NSF 61 approved.
   3. Fitting Coatings: Standard bituminous coating in accordance with Section 51-8, Coatings and Linings, AWWA C151.

C. Joint Material for Ductile Iron Pipe or Fittings:
   1. Push-on Joints, Ductile Iron Pipe: Conforming to requirements of AWWA C111.
   2. Mechanical Joints, Ductile Iron Pipe and Fittings: Conforming to requirements of AWWA C111.
      a. Provide mechanical joints with retainer glands.
   3. Mechanical Couplings: Gasketed, sleeve type with diameter to properly fit specified pipe. Couplings consist of one steel middle ring; two steel, malleable iron or ductile iron followers; two specially compounded rubber gaskets; and high strength low alloy steel bolting system suitable for coupling steel or ductile iron pipe.
      a. Acceptable Manufacturers:
         1) Dresser Manufacturing Division Style 38 and 138; Transition Style 162.
         2) Smith Blair Product No. 411, transition product No. 413.
   4. Wedge Action Retainer Glands:
      a. Provide retainer glands for use on mechanical joints on fittings and valves 24 inches or less. Use fully restrained type joints on fittings and valves greater than 24 inches. Retainer glands on fittings and valves greater than 24 inches not acceptable.
      b. Retainer glands not acceptable in lieu of restrained joints.
      c. Mechanical joint retainer glands cast from ASTM A536, Grade 65-45-12 ductile iron. Wedging mechanism manufactured of ductile iron, heat treated to a hardness of 370 BHN minimum. Provide retainer glands with dimensions that can be used with standardized mechanical joint bell and tee head bolts conforming to requirements of AWWA C111 and AWWA C153. Wedge action screws incorporate twist off nuts in design to ensure proper torque. Provide mechanical joint restraining device for water working pressure rating of 250 psi minimum with a safety factor of at least 2:1.
      d. Install mechanical joint retainer glands in accordance with manufacturer's recommendations. Apply torque to T-bolts in accordance with manufacturer's recommendations. Tighten torque limiting twist off nuts in alternate manner and
clockwise direction. Apply joint deflection before T-bolts are torqued. Where retainer glands are used, limit joint deflection to 2-1/2 degrees maximum.
e. Provide retainer glands designed to prevent joint separation under following pressure ratings:

<table>
<thead>
<tr>
<th>Size (Inches)</th>
<th>Pressure Rating (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>350</td>
</tr>
<tr>
<td>6</td>
<td>350</td>
</tr>
<tr>
<td>8</td>
<td>350</td>
</tr>
<tr>
<td>10</td>
<td>350</td>
</tr>
</tbody>
</table>

5. Acceptable Manufacturers:
b. Ford Meter Box Co., Inc.; Series 1400 (Uni-Flange).
c. Or equal.

D. Gate Valves 3 Inches and Larger: Provide iron body, resilient-seated nut operated, non-rising stem, inside screw gate valves suitable for buried service. Design valves for an operating pressure of 200 psi. Test pressures to 400 psi. Design valves to operate in vertical position.
1. Shop Drawing: Furnish Shop Drawings from manufacturer showing principal dimensions, construction details, and materials used for valve parts.
2. Size and Quantity: As indicated on Drawings.
3. Record of Tests: Furnish test records in accordance with AWWA C509 and Section 6.1.
4. Valve Ends: Mechanical joint in accordance with AWWA C111 with wedge action mechanical joint retainer glands, except in restrained area.
5. Stem Seal: Use Double O ring stem seals.
6. Operating Nuts and Direction of Opening: Square operating nuts conforming to AWWA C509. Valves to open left.
7. Acceptable Manufacturers:
b. ITT Kennedy Valve.
c. Mueller Company.
d. U.S. Pipe.
e. Or approved equal.

E. Gate Valves 2-1/2 Inches and Smaller: Provide ball valves which open to the left, bronze two piece body construction, 600 WOG/150 WSP rating, bottom loaded stem and packing nut threaded to body; NPT ends. Sizes as indicated on Drawings.
1. Acceptable Manufacturers:
b. Or approved equal.

F. Combination Air Valve: Air release valve portion functions to vent air accumulating at high points in water main. Air/Vacuum valve portion exhausts larger quantities of air present in system during filling of water main and allows air to re-enter main during draining of pipe. Provide combination air valves at the locations indicated on the Drawings. Provide combination air valves with cast-iron body and cover, stainless steel float and parts, and stainless steel trim with Buna-N-seat
1. Air release orifice size 3/32-inch
2. Inlet Size: 2-inch
3. Maximum Working Pressure 300 psi
4. Manufacturers:
   a. Val-Matic Valve and Manufacturing Corp.
   b. APCO Valve and Primer Corp.
   c. G.A. Industries.
   d. Or approved equal.

G. Tapping Sleeves and Valves: Verify type of existing pipe and outside diameter of pipe where installing tapping sleeve.
1. Tapping Sleeves: Cast-iron with mechanical joint ends. Provide sleeves in two halves that can be assembled and bolted around main. Extend gaskets entire length of sleeve to form a watertight joint when side bolts are properly tightened.
2. Tapping Valve: Conforming to applicable requirements of AWWA C509 and to subparagraph A above. Provide tapping valves with flanged inlets and mechanical joint outlets.
3. Shop Drawing: Furnish Shop Drawings from manufacturer showing principal dimensions, construction details, and materials used for parts of tapping sleeves and valves.
4. Size and Quantity: As indicated on Drawings.
5. Acceptable Manufacturers:
   a. Kennedy Valve.
   b. American-Darling.
   c. Mueller Company.
   d. A. P. Smith.
   e. Or approved equal.

H. Valve Boxes: Provide cast iron valve boxes of two piece or Buffalo Type for valves up to 12 inches and of three piece for valves up through 20 inches buried in ground. Valve box design of adjustable two section screw type telescoping column or three section with separate base, column inside diameter of 5-1/4 inches, and furnished with a cover marked WATER. Hot coat inside and out with tar or asphalt compound.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Carefully examine material for defects, and do not install material known to be defective.
B. Replace material found defective in manufacture or damaged in transit or handling at no additional expense.
C. Remove defective material from jobsite.

3.2 DEFECTIVE PIPE
A. Architect reserves right to reject defective pipe shipped to jobsite or stored on site. Architect will examine pipe and determine if pipe is damaged prior to installation in trench. Failure of Architect to detect damaged pipe does not relieve Contractor's total responsibility for pipe if it leaks or breaks after installation. Set defective pipe and fittings aside for final inspection by Architect to determine if corrective repairs can be made, or material rejected. Architect will determine extent of repairs. Classify defective pipe as follows:
   1. Damage to interior and exterior paint seal coats.
   2. Damage to interior cement-mortar lining.
   3. Insufficient cement-mortar lining thickness.
4. Poor quality interior paint seal coat.
5. Pipe out of round.
6. Damage pipe barrel area to point where pipe class thickness is reduced.
7. Denting or gouges in plain end of pipe.

3.3 HANDLING OF MATERIAL

A. Handling of Pipe and Fittings:
1. Unload, handle, and store ductile iron pipe, fittings, valves and appurtenances in accordance with AWWA C600. If damage or coating abrasion occurs and is deemed repairable, repair as directed by Architect in accordance with manufacturer’s recommendations. If damage is not repairable in opinion of Architect, reject pipe, fittings, valves, or appurtenances, remove from Project site, and replace at no additional expense.
2. Keep fittings and valves drained and stored before installation in a manner protecting them from damage due to freezing of trapped water.

3.4 CLEANING PIPE AND FITTINGS

A. Clean and remove foreign matter from pipe, fittings and valves before placing in trench. Remove pipe and fittings if interior has been contaminated with oil, gasoline, kerosene or other material damaging to bituminous seal coat or cement-mortar lining and replace at no cost to Owner. Should foreign material or contaminates be observed in previously installed pipe, cease work until foreign material or contaminated pipe is decontaminated or removed.
B. Close open ends of pipe with a watertight plug when pipe laying is not in progress.

3.5 ALIGNMENT AND GRADE

A. Lay and maintain pipe at required lines and grades as indicated on Drawings. Place fittings and valves at required locations with joints centered, spigots forced home, and valve stems plumb. Do not deviate from required line and grade, except with approval of Architect.
B. Joint Deflection:
1. Maximum allowable deflection at joints for push-on joint pipe as follows:

<table>
<thead>
<tr>
<th>Size of Pipe</th>
<th>Deflection Angle</th>
<th>Maximum Deflection (18 ft. Length)</th>
<th>Maximum Deflection (20 ft. Length)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thru 12&quot;</td>
<td>2-1/2&quot;</td>
<td>9-1/2&quot;</td>
<td>10-1/2&quot;</td>
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<tr>
<td>14&quot;-36&quot;</td>
<td>1-1/2&quot;</td>
<td>5-1/2&quot;</td>
<td>6&quot;</td>
</tr>
<tr>
<td>42&quot;-48&quot;</td>
<td>1&quot;</td>
<td>3-3/4&quot;</td>
<td>4&quot;</td>
</tr>
</tbody>
</table>

2. If curve is too sharp for allowable deflection, short lengths of pipe may be used upon approval of Architect.
C. Where underground conditions indicate a change of alignment or grade, make change only with written consent of Architect. When a change in grade is indicated resulting in pipe having more cover than originally anticipated, carefully review class of pipe scheduled for installation at location to ensure it can withstand new loadings. If it cannot, replace with proper class of pipe as directed by Architect.
D. Except at points indicated on Drawings, exercise particular care that no high points are established where air could accumulate. In event field conditions necessitate a change in pipe
profile and, in opinion of Architect, resulting change requires installation of an air valve and manhole, install as additional and extra work in accordance with the General Conditions. If Contractor requests a change in pipe profile to facilitate construction, and resulting change requires installation of an air valve and manhole at high points due to requested change, cost of furnishing and installing air valve and manhole is at Contractor's expense.

3.6 LAYING PIPE

A. General Requirements: Use proper and suitable tools and appliances for proper and safe handling, lowering into trench, and laying of pipes.
1. Do not lay pipe in a wet trench, on subgrade containing frost, and when trench conditions are unsuitable for pipe laying work. If efforts fail to obtain a stable dry trench bottom and Architect determines trench bottom is unsuitable for trench foundation, he will order, in writing, type of stabilization to be constructed.
2. Thoroughly clean pipes and fittings before installing, and keep clean until acceptance of completed work.
3. Lay pipe with bell ends facing in direction of laying unless otherwise indicated on Drawings or directed by Architect.
4. Exercise care to ensure each length abuts next such that no shoulder or unevenness occurs in pipeline.
5. No wedging or blocking permitted in laying pipe unless by written order of Architect.
6. Before joints are made, bed each section of pipe full length of barrel with recesses excavated so pipe invert forms continuous grade with invert of pipe previously laid. Do not bring succeeding pipe into position until preceding length is embedded and securely in place.
7. Dig bell holes sufficiently large to permit proper joint making and to ensure pipe is firmly bedded full length of its barrel.
8. Walking or working on completed pipeline, except as required in tamping and backfilling, not permitted until trench is backfilled one foot deep over top of pipes.
9. Take up and relay pipe that is out of alignment or grade or pipe having disturbed joints after laying.
10. Take up and replace with new, at no additional expense, in-place pipe sections found to be defective.
11. Take necessary precautions to prevent floating of pipeline by accumulation of water in trench or collapse of pipeline. Should floating or collapse occur, restore at no additional expense.
12. Bedding materials and concrete work for pipe bedding as specified previously in Section 31 23 33.
13. Take every precaution to prevent foreign material from entering pipe while it is being placed in line. During laying operations, do not place debris, tools, clothing, or other materials in pipe.
14. Close openings in pipeline with watertight plugs when pipe laying is stopped at close of day's work or for rest breaks, meal periods or other reasons.
15. Place enough backfill over center sections of pipe to prevent floating.
16. Place underground warning tape over pipeline as specified in Section 31 23 33.
17. Carry out cutting of pipe with an abrasive wheel, rotary wheel cutter, guillotine pipe saw, milling wheel saw or other equipment specifically designed for that purpose. Use of chisels or handsaws not permitted. Grind smooth cut ends and rough edges, and for push-on connections, cut end should be beveled slightly.

B. Joints. Exercise care when making each joint, and make in accordance with pipe supplier's specifications and in accordance with following instructions:
1. Ductile Iron Pipe:
   a. Push-On Joints: Join pipe in accordance with AWWA C600, Section 3.4.1 or latest revision and the following.
1) Assemble push-on joint to provide tight, flexible joints that safely permit movement caused by expansion and contraction due to temperature changes and by ground movement.

2) Thoroughly clean inside of bell and outside of spigot end to remove oil, grit, excess coating and other foreign matter. Flex circular rubber gasket inward and insert in gasket recess of bell socket. Apply a thin film of gasket lubricant to either inside surface of gasket or spigot end of pipe or both. Gasket lubricant to be supplied by pipe manufacturer and approved by Architect prior to its use.

3) Enter spigot end of pipe into socket with care to keep joint from contacting ground. Complete joint by forcing plain end to bottom of socket with a forked tool or jack type tool or other device as may be approved by Architect. Mark pipe that is not furnished with a depth mark before assembly to ensure spigot end is inserted to full depth of joint. File or ground field cut pipe lengths to resemble spigot end of pipe as manufactured. Complete assembly instructions are available from pipe manufacturer.

b. Mechanical Joint: Furnish sworn statement that inspection and tests on parts of this type joint have been made and met as specified. Join in accordance with AWWA C600, Section 3.4.2., latest revision, and the following:

1) Centrally locate spigot in bell. Thoroughly brush contact surfaces of rubber gasket seal with a wire brush just prior to assembly. Remove loose rust or foreign material and brush with soapy water prior to slipping gasket over spigot end and into bell. Normal range of bolt torques applied to standard cast iron bolts in joint are as follows:

<table>
<thead>
<tr>
<th>Size Inches</th>
<th>Range of Torque Ft. - Lb.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8</td>
<td>40-60</td>
</tr>
<tr>
<td>3/4</td>
<td>60-90</td>
</tr>
<tr>
<td>1</td>
<td>70-100</td>
</tr>
<tr>
<td>1-1/4</td>
<td>90-120</td>
</tr>
</tbody>
</table>

2) Above torque loads may be applied with torque measuring or indicating wrenches. Torque wrenches may be used to check application of approximate torque loads applied by men trained to give an average pull on a definite length of regular socket wrench. Following lengths of wrenches should satisfactorily produce above range of torques when used by average man:

<table>
<thead>
<tr>
<th>Size Inches</th>
<th>Length of Wrench Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8</td>
<td>8</td>
</tr>
<tr>
<td>3/4</td>
<td>10</td>
</tr>
<tr>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>1-1/4</td>
<td>14</td>
</tr>
</tbody>
</table>

3) When tightening bolts, it is essential that gland be brought up toward pipe flange evenly, maintaining equivalent distance between gland and face of flange at all points around socket. This may be done by partially tightening bottom bolt first, then top bolt, next bolts at either side, and last remaining bolts. Repeat this cycle until bolts are within above range of torques. If
effective sealing is not attained at maximum torque indicated above, disassemble and reassemble joint after thorough cleaning. Avoid overstressing of bolts to compensate for poor installation practice.

c. Retainer Glands: Install retainer glands as with mechanical joints, except after joint bolts are tightened. Tighten restraining screws in retainer gland. Required torque range for retaining screws as specified by retainer gland manufacturer.

d. Restrained Joints: Install in accordance with manufacturer’s recommendations.

3.7 VALVE INSTALLATION

A. Examination of Material: Prior to installation, inspect valves for direction of opening, freedom of operation, tightness of pressure containing bolting, cleanliness of valve ports and especially seating surfaces, handling damage and cracks. Correct defective valves or hold for inspection by Architect.

B. Installation: Set and join to pipe in manner specified in Article 3.06. Provide valves 12 inches and larger with crushed stone or concrete pad support so that pipe does not support weight of valve. Set truly vertical.

C. Valve Protection: Provide valves with a valve box. Set top of valve box neatly to grade of surface of existing ground, unless directed otherwise by Architect. Do not transfer shock or stress to valve, and center and plumb box over wrench nut of valve. Do not use valves to bring misaligned pipe into alignment during installation. Support pipe in manner to prevent stress on valve.

3.8 THRUST RESTRAINT

A. General Requirements: Provide each nonrestrained cap, tee, and bend (both horizontal and vertical) with thrust restraints as detailed on Drawings.

B. Concrete Reaction Backing: Place concrete reaction backing between undisturbed solid ground and fitting to be anchored. Locate backing, unless otherwise shown or directed, to contain resultant thrust force and so that pipe and fitting joints are accessible for repair.

3.9 CONNECTIONS TO EXISTING WATER MAINS AND INTERRUPTIONS OF SERVICE

A. Notification: Notify Owner a minimum of seven working days in advance of anticipated time for installing a connection to water system or when necessary to close down a portion of existing system to carry out work. Under no circumstances are valves to be manipulated on existing water system, except under direct supervision of a representative of Owner.

B. Owner’s Restrictions: Owner reserves right to designate day and time when existing water main may be removed from service. Owner may require that this work be done at night or on a weekend. In addition, Owner further reserves right to require that work on installation of connections between existing and new water mains, or in other areas where service to customers will be interrupted, be carried out continuously and expeditiously until water service is restored.

C. Notification of Customers: Give adequate and timely notice to affected customers that construction will require interruption of service.

D. Installation: In cases where connections to existing water system or other work require an interruption of water service, carefully plan work ahead in close coordination with Architect and Owner. Obtain Architect’s approval of installation schedule and procedure before work is started, and procure necessary materials, tools and equipment before work is started. Make
provision in prices bid for connections, and laying pipe adjacent to existing fittings, for adequate personnel to be available for continuous operations and payment of premium time. No additional or extra payment will be made for extra personnel and overtime for installation of connections, cutting and capping of existing water mains, or passing of existing fittings, whether or not Owner directs that work be continuous, without interruption, and that this work be at night or on a Sunday.

E. Installation of Tapping Sleeves and Valves: Use tapping machine, and strictly follow manufacturer’s instructions. Submit procedure for approval prior to installing. Personnel performing tap to have been regularly engaged in installing taps of this size for at least 10 years and have at least 5 installations in successful operation for 5 years.

3.10 FIELD QUALITY CONTROL

A. Hydrostatic Pressure and Leakage Test: Conduct pressure and leakage tests in accordance with Section 01666.

B. Cleaning Prior to Tests: Before tests are conducted, clean piping by a method acceptable to the Architect.

3.11 DISINFECTION OF WATER MAINS

A. Disinfect and flush with water in accordance with provisions of Section 01656.

END OF SECTION 33 11 13
SECTION 33 40 00 - STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The work specified in this Section consists of constructing the various types and sizes of piped storm sewer lines and in-line appurtenances.

B. Related Sections:
   1. Section 31 23 33.13: Trenching and Backfilling for Site Utilities.
   2. Section 33 49 00: Storm Drainage Structures.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. AASHTO M252, Corrugated Polyethylene Drainage Pipe (Type S).
   2. AASHTO M294, Corrugated Polyethylene Drainage Pipe, 300 to 1200-mm Diameter.

B. American Society for Testing and Materials (ASTM):
   1. ASTM A 82, Specification for Steel Wire, Plain, for Concrete Reinforcement.
   2. ASTM A 185, Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
   3. ASTM A 615, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   4. ASTM C 32, Specification for Sewer and Manhole Brick (Made from Clay or Shale).
   5. ASTM C 33, Specification for Concrete Aggregates.
   7. ASTM C 144, Specification for Aggregate for Masonry Mortar.
  11. ASTM C 478, Specification for Precast Reinforced Concrete Manhole Sections.
  15. ASTM D 1785, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Schedules 40, 80 and 120.
  20. ASTM D 3034, Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
22. ASTM F 477, Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
23. ASTM F 667, Large Diameter Corrugated Polyethylene Tubing and Fittings, Spec. for.

C. Commonwealth of Pennsylvania Department of Transportation (PENNDOT), Specifications Publication 408/2003, as supplemented.
1. PENNDOT Section 610.2 Pipe For Pipe Underdrain and Pavement Base Drain.

D. Federal Specifications:

1.3 SUBMITTALS

A. Shop Drawings and Product Data: Submit completely dimensioned shop drawings, catalog cuts and such other data as required to provide complete descriptive information for the following:
1. Basic Materials.
2. Pipe and Fittings.
3. Piping Specialties.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Transport, handle and store pipe materials and the associated materials specified herein, in the manner recommended by the respective materials manufacturers so as to prevent damage and defects to their respective materials.

1.5 SITE CONDITIONS

A. Environmental Requirements:
1. Keep trenches dewatered until pipe joints have been made and concrete placements have cured.
2. Do not lay pipe in water or on bedding containing frost.
3. Do not lay pipe when weather conditions are unsuitable, as determined by the Engineer, for pipe laying work.
4. To improve workability of Preformed Plastic Sealing Compound during cold weather, store such at temperature above 70 degrees F or artificially warm compound in a manner satisfactory to the Engineer.
5. During warm weather stiffen Preformed Plastic Sealing Compound by placing under cold water or by other means as recommended by the compound manufacturer.

PART 2 - PRODUCTS

2.1 BASIC MATERIALS

A. Non-Shrink Non-Metallic Grout: As specified in Section 03 60 00: Grouting.
B. Waterproofed Mortar: Conforming to requirements of ASTM C 270 for Type M, 2500 psi (Parts by volume include: One part cement, 1/4 part lime, and sand at not less than 2-1/4 nor more than three times the sum of the volumes of cement and lime used and of the following materials:

1. Waterproofing Agent: Medusa Waterproofing Powder by Medusa Portland Cement Co.;  Hydratite by Grace Construction Materials; or Hydrolox by Chem-Master Corp. Add the Medusa product in the ratio of two pounds per bag of cement; add the other products per manufacturer's recommendations.
2. Portland Cement: Conforming to ASTM C 150, Type I.
3. Hydrated Lime: Conforming to ASTM C 207, Type S.
5. Water: Clean and free from deleterious amounts of acids, alkalis, and organic materials.

C. Drainage Structure Brick: Masonry units made from clay or shale conforming to physical and dimensional requirements of ASTM C 32, Grade MS.

D. Riprap: Field stone or rough unhewn quarry stone of approximately rectangular shapes. Provide stones of such quality that will not disintegrate on exposure to water or weathering.

1. Minimum thickness: 9 inches measured perpendicular to face of stone.
2. Minimum face dimensions: Not less than stone thickness.
3. Weight: Not less than 70 percent of the individual pieces weighing 150 lbs. maximum and 10 percent weighing less 100 lbs. minimum.

2.2 PIPE AND FITTINGS

A. High Density Polyethylene Corrugated Pipe: Provide corrugated pipe and fittings with integrally formed smooth interior, manufactured from polyethylene compounds which meet or exceed the requirements of Type III, Category 4 or 5, Graded P33 or P34, Class C according to ASTM D 1248. Clean reworked material may be incorporated into the compounds.

1. Pipe and fittings showing visible defects and foreign inclusions in the material are not acceptable.
2. Pipe lengths shall have cleanly and squarely cut ends so as not to adversely affect pipe joining.
3. Provide corrugated fittings (corrugations shall match the pipe) of either molded or fabricated type. Fittings by other than the pipe manufacturer are not acceptable.
4. Joints: Split coupling type and of a corrugated design to engage the pipe corrugations for a minimum of four corrugations, two on each side of the pipe joint, creating a watertight seal.
5. Gaskets: Provide neoprene sponge gaskets on each pipe joint where pipe is installed under roadway embankments. Insert the gasket under the coupling on each side of the pipe joint.

B. Solid Wall Polyvinyl Chloride (PVC) Pipe: Provide pipe which is permanently marked with manufacturer's trademark, size, and ASTM conformance designation.

1. Pipe, Solid Wall, Size 6 through 15 Inch Diameters: Type PSM SDR-35 conforming to ASTM D 3034 requirements, or Type PS-46 conforming to ASTM F 789 requirements for pipe sizes above 15 inch to 18 inch diameter.
2. Pipe, Solid Wall, Size 18 through 27 Inch Diameters: Type PS-46 conforming to ASTM F 679 requirements.
3. Fittings: Commercially manufactured molded fittings made from PVC compounds having a cell classification of 12454-B, 12454-C, or 13343-C as defined in ASTM D 1784.
4. Joints: Push-on style joint, with elastomeric gasket, conforming to ASTM D 3212 requirements for joint design; gasket conforming to ASTM F 477 requirements for material specifications, providing a watertight seal.
	a. Pipe bell design shall incorporate the gasket locked in a groove so as to prevent gasket displacement when pipes are joined.
C. Schedule Type Polyvinyl Chloride (PVC) Pipe: Schedule 40, Type I PVC soil and waste pipe conforming to ASTM D 1785 requirements for pipe, and ASTM D 2466 for fittings.
   1. Solvent-weld Joints: Conforming to ASTM D 2564 requirements, providing a water tight seal.

D. Perforated Wall and Solid Wall PVC Pipe Drains: Provide pipe which is permanently marked with manufacturer’s trademark, pipe size and ASTM conformance designation.
   1. PVC Pipe and Fittings: Provide pipe conforming to ASTM D 1785, Schedule 40, and PVC socket-type pipe fittings conforming to ASTM D 2467. Slotted pipe shall have four rows of 0.025 inch slots spaced 1/2-inch apart.
   2. PVC Pipe and Fitting Solvent Cement: Material conforming to ASTM D 2564.

E. Rubber-Gasket Joints, Buried Pipe: Conforming to ANSI A21.11 requirements.
   1. For buried pipe installation, provide push-on or mechanical joints except where other types of joints are indicated on the Drawings or required by the Specifications.
   2. For buried pipe installation, provide mechanical joints except where other types of joints are indicated on the Drawings or required by the Specifications.
   3. For buried pipe installation, provide push-on joints except where other types of joints are indicated on the Drawings or required by the Specifications.
   4. All joints shall be water tight.

F. PENNDOT Conforming Pipe Underdrain: The Contractor shall use the following pipe underdrain materials.
   1. Perforated Plastic Semi-circular Pipe: Extruded or moulded using a high density, flexible plastic with minimal material thickness of 0.125 inches; and conforming to the requirements of PENNDOT Section 610.2.

2.3 PIPING SPECIALTIES

   1. Acceptable Manufacturers:
      a. FERNCO Inc., CMA Concrete Manhole Adapter, Distributed by the General Engineering Company.
      b. Or equal.

B. Sleeve Type Pipe Seal: Sleeve type pipe seal used for core-drilled connection of piping to existing manholes. In general, the pipe seal shall conform to the requirements of ASTM C 923 and shall incorporate a positive compression fit of the gasket to both the manhole and the pipe.
   1. Acceptable Manufacturers:
      a. Press-Seal Gasket Corp., Concrete Products Supply Co.; PSX Seal.
      b. Or equal.

2.4 STORM DRAINAGE STRUCTURES

A. Concrete Inlet Construction Options: The Contractor is permitted the option to construct inlets in the Project of types specified immediately following. However only one type of inlet construction permitted in the Project except where required otherwise on Drawings.

B. Cast-In-Place Concrete Inlet: Concrete work as specified in Section 03 30 53: Miscellaneous Cast-in-Place Concrete. Field cast reinforced concrete inlet to conform to type and design indicated on the Drawings.
   1. Concrete Strength and Type: Class A (4,000 psi); Type I (Normal) Cement.
2. Frame and Grate: Provide grating fabricated of structural steel bars and a structural steel angle frame with integral concrete anchoring lugs. Design to sustain HS-20 loading according to current AASHTO Specifications.

C. Precast Concrete Inlets: Conforming to Pennsylvania Department of Transportation’s Type M. Concrete shall conform to Class A as specified in Section 03 30 53: Miscellaneous Cast-in-Place Concrete. Reinforce openings in inlet with reinforcement bars conforming to ASTM A 615. Reinforce walls and bottom with welded wire fabric conforming to ASTM A 185. Cast steel angle in top of inlet to hold grate.
   1. Precast Concrete Leveling/Adjusting Units: Provide units of not less than two inches thickness and of materials and construction as specified for Precast Concrete Inlets.
   2. Inlet Frame and Grate: Provide gratings of the design indicated and fabricated of structural steel bar and angle with angle frame. Design to sustain HS-20 loading according to current AASHTO Specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Field Inspection: Inspect each section of pipe and each pipe fitting before laying in conformance with the inspection requirements of the appropriate referenced standard.
   1. Inspect precast manhole components in accordance with requirements of ASTM C 478 regarding repairable defects and defects subject to rejection by the Engineer.

B. Rejected Products: Remove rejected Products from the Project site and replace with new Products at no increase in Contract Price.
   1. Pipe already laid and later found defective will not be accepted and shall require replacement at no increase in Contract Price.

3.2 PREPARATION

A. General Requirements: Do not lay pipe or set or construct inlets, endwalls, or manhole bases in excavations containing water or on subgrade containing frost. Keep excavations water-free until concrete pours of whatever nature have cured. Keep pipe and manhole interiors cleared of debris as construction progresses.

B. Trenching for Site Utilities: Perform earthwork for buried site drainage piping and associated concrete structures as specified in Section 31 23 33.13: Trenching and Backfilling for Site Utilities.
   1. Bedding materials and concrete work for pipe bedding as specified in Section 31 23 33.13: Trenching and Backfilling for Site Utilities.

3.3 CONSTRUCTION

A. General Requirements: Use proper and suitable tools and appliances for the proper and safe handling, lowering into trench and laying of pipes.
   1. Lay pipe proceeding upgrade true to line and grades given. Lay bell and spigot pipe with bell end upgrade. Lay tongue and groove pipe with groove end upgrade. No wedging or blocking permitted in laying pipe unless by written order of the Engineer.
   2. Exercise care to insure that each length abuts against the next in such manner that no shoulder or unevenness of any kind occurs along inside bottom half of pipe line.
   3. Before joints are made, bed each section of pipe full length of barrel with recesses excavated so pipe invert forms continuous grade with invert of pipe previously laid. Do
not bring succeeding pipe into position until the preceding length is embedded and securely in place. Dig bell holes sufficiently large to permit proper joint making and to insure pipe is firmly bedded full length of its barrel.

4. Walking or working on completed pipe line, except as necessary in tamping and backfilling, is not permitted until trench is backfilled one-foot deep over top of pipes.

5. Take up and relay pipe that is out of alignment or grade, or pipe having disturbed joints after laying.

B. Piping Laying and Joining: Perform pipe laying and joining in strict accordance with manufacturer's installation instructions, reference standards as included, and such additional requirements as specified herein.

1. Laying/Joining Specified Types of Plastic Pipe: Installation and joint assembly according to ASTM D 2321 requirements and for Class I bedding material as included therein.

2. Solvent-Weld Joints: Use chemical solvent welding components as recommended by the pipe material manufacturer and comply with said pipe manufacturer's cleaning and joining instructions.

C. Underdrain Installation: Install underdrain using bedding and backfill materials specified in Section 31 23 33.13: Trenching and Backfilling for Site Utilities. Perform trench preparation, backfilling, and compaction in accordance with Section 31 23 33.13: Trenching and Backfilling for Site Utilities. Provide materials indicated in underdrain installation details on the Drawings and install such to conform to the details indicated.

D. Storm Drainage Structure Installations: Do not complete storm drainage structure construction until after grading has been finished and the necessary arrangements have been made to ensure suitable connections and tie-ins at proper grade and alignment.

1. Set precast drainage structures on a bed of aggregate, as indicated on the Drawings, over undisturbed or well compacted earth.

2. Set inlet and outlet pipes in drainage structures true to line and grade, with the pipes cut flush with inside face of walls, and extend the pipes a sufficient distance beyond the outside face of drainage structure walls to provide for pipe section connections.

3. Fill annular space between installed pipes and drainage structure openings with Waterproofed Mortar. Trowel mortar to a smooth, flat finish both inside and outside.

4. Install inlet frame and grate with frame adjusted to the proper elevation using Precast Concrete Leveling/Adjusting Units set in Waterproofed Mortar; or using Drainage Structure Brick set in Waterproofed Mortar.

E. Connections To Existing Precast Concrete Structures: Expose the existing concrete structures to the extent required to perform the new connection work indicated on the Drawings and as specified herein:

1. Make openings of sufficient size to accommodate the pipe and one inch of annular mortar space. Fill such annular space with Waterproofed Mortar thoroughly compacted in place.

2. Set pipes entering such existing concrete structures flush with inside face of such structures.

3. As required, fill bottom of structures with Class B concrete to invert of new pipe and slope surface 1¼-inch to outlet pipe.

F. Connections To Existing Precast Concrete Structures: Expose the existing concrete structures to the extent required to perform the new connection work indicated on the Drawings and as specified hereinafter.

1. The option is allowed to make connections by the Cut-In Opening Method (with PVC Waterstop and Non-Shrink Non-Metallic Grout), or by the Core-Drilled Opening Method (with Sleeve Type Pipe Seal).

2. Cut-In Opening Method: Cut the required opening or openings by such methods so as to prevent cracking and spalling concrete. Make openings of sufficient size to accommodate the pipe with PVC Waterstop installed and one inch of annular grout.

3. Core-Drilled Opening Method: Core-drill the required opening or openings true to line and absolutely smooth cored surface. Install the Sleeve Type Pipe Seal expanded in place in accordance with the manufacturer's installation instructions.

3.4 FIELD QUALITY CONTROL

A. PVC Pipe Drains Testing: Perform a Deflection Test on the PVC Pipe Drains installed in the project.

1. Testing Equipment: Provide GO/NO-GO Mandrel and incidental equipment for Deflection Test on PVC pipeline. Mandrel to conform to following requirements:
   a. Cylindrical in shape with not less than nine arms spaced evenly around the mandrel.
   b. Minimum contact length of mandrel arms with pipe wall not less than the nominal diameter of the pipe being tested.
   c. Mandrel diameter 95 percent of inside pipe diameter.

2. Deflection Test, PVC Pipe: In addition to air tests and infiltration test, conduct deflection tests on PVC pipe. Test each PVC pipeline installed.
   a. Conduct deflection testing not less than 30 days after PVC pipelines are backfilled.
   b. Pull mandrel through pipe section manually; powered pulling devices not permitted.
   c. Consider any pipeline section through which the mandrel cannot pass to have more than maximum allowable deflection of five percent.

END OF SECTION 33 40 00
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Frames and covers for sanitary and storm manholes.
   2. Frames and grates for storm inlets.

B. Related Sections:
   1. Quality Control: Applicable Division 1 specification section.
   2. Section 31 22 19: Finish Grading.
   4. Section 03 30 53: Miscellaneous Cast-In-Place Concrete.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM A 48, Gray Iron Castings.
   3. ASTM A 615, Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, Spec for.
   4. ASTM C 270, Mortar for Unit Masonry.
   5. AASHTO M 105 (ASTM A 48), Class No. 207, Grey Iron Castings.
   6. ASTM A 47/A 47M, Grade 24018, Malleable Iron Castings.
   7. ASTM A 536, Grade 60-40-18, Ductile Iron Castings.

B. Federal Specifications:

1.3 SUBMITTALS

A. Shop Drawings and Product Data:
   1. Manufacturer's published detail drawings, modified to suit design conditions if required, and Contractor prepared drawings as applicable.
   2. Manufacturer's descriptive literature and specifications covering the product specified. Include installation information.
   3. Shop Drawings to indicate types of materials, dimensions and details including location of reinforcement, inserts, anchors, connections, accessories, joints, openings, and setting details.

B. Certificates:
   1. Certified records or reports of results of shop tests, such records or reports to contain a sworn statement that shop tests have been made as specified.
   2. Manufacturer's sworn certification that components and products will be manufactured in accordance with specified reference standards for components and products.

C. Design Calculations: Submit structural calculations for structures furnished under this Section. Have calculations sealed and signed by a Registered Professional Engineer.
1.4 QUALITY ASSURANCE

A. Quality Control:
   1. Maintain uniform quality of products and component compatibility by using products of one manufacturer in the case of precast reinforced concrete manholes.

B. Certifications:
   1. Obtain certificate of construction compliance with ASTM C 478 from the precast reinforced concrete manhole manufacturer. Submit same certificate as part of required submittals.
   2. Obtain certificate of material compliance with ASTM A 48, Class 30 tensile strength from the manhole frame and cover manufacturer. Furnish certification that tensile test bars were from same pour as castings. Submit the certificates as part of required submittals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Transport and handle products specified herein in a manner recommended by the respective manufacturers of such to prevent damage and defects.

PART 2 - PRODUCTS

2.1 BASIC MATERIALS

A. Manhole Frame and Cover:
   1. Grey iron castings conforming to ASTM A 48, Class 35. Provide castings of uniform quality, free from blowholes, porosity, hard spots, shrinkage distortion, or other defects. Frame and cover design and dimensions as indicated on Drawings.
   2. Provide casting designed for AASHTO H-20 loading.
      a. Finish: Bearing surfaces machined to prevent rocking and rattling.
      b. Identification: Cast the applicable word integrally on cover in 2 inch size raised letters.
      d. Tensile Test Bar: Size B, cast separately, but poured from same iron as castings they represent.
      e. Aluminum Inner Cover: Fabricate from aluminum alloy 6061-T6 sheet or plate to dimensions indicated on Drawings. Provide cover with vents and lift handle.
      f. Cover Gasket: One piece O-ring gasket factory installed in a machined rectangular or dovetail groove in the cover bearing surface.
      g. Gasket material of neoprene composition having good abrasion resistance, low compression set, 40 durometer hardness and suited for use in sanitary sewer manholes.
   3. Acceptable Manufacturer:
      b. PENNDOT Bulletin 15.
      c. Or approved equal.
   4. Inlet Frame and Grates:
      a. Provide inlet grates and frames as shown on the PENNDOT Standard Drawings RC-34 and as shown on the Drawings. Grates and frames may be either fabricated structural steel or cast gray, malleable, or ductile iron.
   5. Fabricated:
      a. Coat structural steel grates with bituminous paint in the shop or in the field, prior to placement.
b. Coat structural steel frames with bituminous paint at the time of casting the concrete inlet top unit.
c. As an alternative to bituminous paint, hot dip galvanize structural steel grates and frames.

6. Castings:
   a. Gray iron castings conforming to AASHTO M 105 (ASTM A 48), Class No. 207
   b. Malleable iron castings conforming to ASTM A 47/A 47M, Grade 24018
   c. Ductile iron castings conforming to ASTM A 536, Grade 60-40-18 unless otherwise specified.
   d. Sandblast all castings or otherwise effectively clean scale and sand so as to present a smooth, clean, and uniform surface.

7. Acceptable Manufacturers:
   b. PENNDOT Bulletin 15
   c. Or approved equal.

2.2 SOURCE QUALITY CONTROL

A. Furnish manufacturers’ certified test records or reports with sworn statement of tests made to establish material quality.

B. Furnish proof of current listing in PENNDOT Bulletin 15.

C. Engineer reserves right to accept certified test records or reports of previously conducted tests.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect installed precast reinforced concrete manhole components before setting frames, top units, and covers in accordance with requirements of ASTM C 478 regarding repairable defects and defects subject to rejection by the Engineer.

B. Frame and Cover Installation: Where required, make final adjustment of frame to elevation using materials specified in Part 2 Products.
   1. Set precast grade rings in Water-proof Mortar, of thickness not to exceed 3/4 inch maximum and 3/8 inch minimum. Wet, but do not saturate precast grade rings immediately before laying.
   2. Precast grade ring: Pre-set to proper plane and elevation using wedges or blocks of cementitious material not exceeding one square inch wide on all sides. No more than four wedges or blocks per grade ring permitted. Incorporate wedges or blocks in fresh mortar in a manner to completely encase each. Crown fresh mortar to produce squeeze-out between grade rings. Tool exposed joints with appropriately shaped tool and compact mortar edge into joints. Clean off excess mortar prior to initial mortar set.
   3. Bolt manhole frames in place on manhole top section, or on leveling units if required, after installing 1/2 inch thick preformed plastic sealing compound on bearing surface of manhole frame. Remove excess sealing compound squeeze-out after manhole frame is bolted in place.
   4. Use bolts of sufficient length to properly pass through leveling units, if any, engage full depth of manhole top section inserts and allowing enough threaded end to pass through manhole frame to properly tighten nut and washer. Tighten manhole frame bolts after mortar has cured.
C. Frame and Grate Installation: Where required, make final adjustment of top section and frame to elevation using materials specified in Part 2 Products. If grade sections are used, they must encompass all four sides of the box.
   1. Set loose frames in cast-in-place inlet tops only where they are securely held in position by sturdy stringers spanning the entire width of the excavation and confirmed to be to final pavement grade prior to placement of concrete.

3.2 FIELD QUALITY CONTROL

A. General: Make a visual inspection of each unit constructed to ensure compliance with installation requirements.
   1. Repair or replace defective materials and workmanship, as is the case, and conduct such additional inspection and such subsequent repairs as required until manholes and inlets meet requirements.
   2. Materials and methods used to make manhole repairs must meet with Engineer's approval prior to use.
   3. Make repairs and replacements at no additional expense to Owner.

END OF SECTION 33 49 00
SECTION 33 60 80 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions,” “Special Requirements” and “General Requirements form a part of this section by reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. Section Includes:
1. Thermal insulation for piping and equipment in valve manholes.
2. Jacketing and accessories for insulation.
3. Thermal insulation for steam tunnels and steam manholes

1.3 RELATED SECTIONS

A. Section 33 63 00 – Steam Distribution.
B. Section 33 61 00 – Hydronic Energy Distribution.
C. Section 33 05 16 – Concrete Utility Structures.

1.4 SUBMITTALS

A. Product Data: Provide product description, list of materials and thickness for each service or equipment scheduled, locations, and manufacturer’s installation instructions.
B. Indicate manufacturer, trade names, and model numbers, components, thermal performance, arrangement, and accessories being provided.
C. Include applicable literature, catalog material, or technical brochures.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of insulation, adhesives, mastics, and insulation cements.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Minimum experience on at least 5 projects of a similar nature in past 5 years.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver all materials to the job site and protect the insulation against dirt, water, chemical and mechanical damage before, during, and after installation. Do not install damaged insulation and remove it from the job site.
B. Deliver insulation, coverings, cements, adhesives, coatings, etc. to the site in factory-fabricated containers with the manufacturer’s stamp or label affixed showing fire hazard ratings of the products, name of manufacturer and brand.

C. Installed insulation which has not been weatherproofed shall be protected from inclement weather by an approved waterproof sheeting installed by the Contractor. Any water-damaged insulation shall be removed and replaced by the Contractor at no additional cost.

PART 2 - PRODUCTS

2.1 PIPE INSULATIONS

A. Manufacturers:
   2. Pittsburgh Corning Corporation.

B. Glass Fiber: ASTM C 547, Type I; rigid molded, noncombustible.

C. ‘K’ (‘ksi’) Value: 0.23 at 75 degrees F Mean Temperature (0.033 at 24 degrees C).

D. Maximum Service Temperature: 0 degrees F to 850 degrees F (minus 18 degrees C to 454 degrees C).

E. Vapor Retarder Jacket: White kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self sealing longitudinal laps and butt strips or AP jacket with outward clinch expanding staples coated with vapor barrier mastic as needed.

F. Hydrous Calcium Silicate Pipe Insulation: ASTM C 533, Type I; rigid molded pipe; asbestos-free color coded throughout material thickness.

G. ‘K’ (‘ksi’) Value: 0.42 at 300 degrees F Mean Temperature (0.058 at 149 degrees C) as tested in accordance with ASTM C 335.

H. Maximum Service Temperature: 1200 degrees F (649 degrees C).

I. Compressive Strength (block): Minimum of 100 psi to produce 5 percent compression at 1 ½-inch thickness.

J. Non-combustible as determined by test following ASTM E 136.

K. Tie Wire: 16 gage (0.045 mm) stainless steel with twisted ends on maximum 12-inch (300 mm) centers.

L. Field Applied Jackets:
   1. Aluminum Jacket: 0.016 inch (0.045 mm) thick sheet, (smooth/embossed) finish, with longitudinal slip joints and 2-inch (50 mm) laps, die shaped fitting covers with factory applied moisture barrier.
   2. Stainless Steel Jacket: Type 304 stainless steel, 0.010 inch (0.25 mm), (smooth/corrugated) finish.

2.2 EQUIPMENT INSULATION
A. Manufacturers:
2. Pittsburgh Corning Corporation.

B. Rigid Fiber Glass Board: ASTM C 612, Type IA & IB; rigid.
1. ‘K’ (ksi) Value: 0.23 at 75 degrees F Mean Temperature (0.033 at 24 degrees C).
3. Density: 3.0 lb./cu. Ft. (48 kg./cu. m) density.
4. Vapor Retarder Jacket: Aluminum foil reinforced with fiber glass yarn and laminated to fire-resistant kraft shall be secured with UL listed pressure sensitive tape and/or outward clinch expanding staples and vapor barrier mastic as needed.

C. Rigid Fiber Glass Board: ASTM C 612, Type II; rigid, noncombustible.
1. ‘K’ (ksi) Value: 0.23 at 75 degrees F Mean Temperature (0.033 at 24 degrees C).
3. Density: 3.0 lb./cu. Ft. (48 kg./cu. m) density.

D. Hydrous Calcium Silicate Block Insulation: ASTM C 533; rigid molded block; asbestos free color coded throughout material thickness.
1. ‘K’ (ksi) Value: 0.41 at 300 degrees F Mean Temperature (0.058 at 149 degrees C) when tested in accordance with ASTM C 177 and C 518.
3. Compressive Strength (block): Minimum of 100 psi to produce 5 percent compression at 1 ½-inch thickness.

E. Securement: Insulation shall be securely banded in place, tightly butted, joints staggered and secured with 16 gauge galvanized or stainless steel wire or ½-inch by .015 galvanized steel bands on 12-inch maximum centers for large areas.

F. Field Applied Jackets:
1. Aluminum Jacket: 0.016-inch (.045 mm) thick sheet, smooth/embossed finish, with longitudinal slip joints and 2-inch (50 mm) laps.
2. Weatherproof coating: Provide non water-vapor retarder, non-burning, weatherproof coating for use over insulation where “breathing” is required.

2.2 STEAM TUNNEL AND UTILITY MANHOLE INSULATION

A. Acceptable Manufacturers:
1. Exterior Insulation: Dow Chemical Company Styrofoam Brand insulation
2. Interior Insulation: Same as Equipment Insulation above.

B. Tunnel insulation, for application to top exterior or sides of concrete steam tunnel or manhole:
1. Closed cell extruded polystyrene foam insulation; ASTM C 578 – 92, Type VI.
2. Maximum service temperature: 165 degrees F.
5. Water Absorption: 0.1 percent maximum, by volume; ASTM C 272-91.
6. Cover Material: Pressure treated plywood, one-quarter inch thick.

C. Tunnel insulation, for application to top interior or sides of concrete steam tunnel or manhole:
1. Rigid Fiber Glass Board: ASTM C 612, Type IA & IB; rigid.
2. ‘K’ (ksi) Value: 0.23 at 75 degrees F Mean Temperature (0.033 at 24 degrees C).
4. Density: 3.0 lb./cu. Ft. (48 kg./cu. m) density.
3.1 EXAMINATION AND PREPARATION

A. Verify that piping has been successfully tested for leakage before applying insulation materials.
B. Verify that all surfaces are clean, dry and free of foreign material.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer’s recommendations, building codes and industry standards.
B. Continue insulation vapor barrier through penetrations except where prohibited by code.
C. Piping Insulation
D. Locate insulation and cover seams in least visible locations.
E. Neatly finish insulation at supports, protrusions, and interruptions.
F. Provide insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature with vapor retardant jackets with self sealing laps. Insulate complete system.
G. In dual temperature systems seal all pipe terminations including fittings, wall penetrations, and pipe supports with vapor barrier mastic such as Foster 30-35 or equal. In addition, in brine or chilled water pipe systems vapor seal pipe terminations every four pipe sections, using Foster 30-35 or equal.
H. For insulated pipes conveying fluids above ambient temperature, secure jackets with self sealing lap or outward clinched, expanded staples. Bevel and seal ends of insulation at equipment, flanges and unions.
I. Provide insert between support shield and piping on piping 1 ½-inches (38 mm) diameter or larger. Fabricate support shields from rigid, heavy density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths:
   1. 1 ½-inch to 2 ½-inch pipe size 10-inches long
   2. 3-inches to 6-inches pipe size 12-inches long
   3. 8-inches to 10-inches pipe size 16-inches long
   4. 12-inches and over 22-inches long
J. For pipe exposed in manholes or exterior applications, finish with aluminum jacket or stainless steel jacket. Jacket seams shall be located on bottom side of horizontal piping. PVC covers are not acceptable.
K. Where jacketing is not practical, use coating such as Insulkote or Foster 35-00.
L. Equipment Insulation
M. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation, if necessary. As required, secure insulation to equipment with studs, pins, clips, adhesive, wires or bands.
N. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retardant cement.
O. Provide insulated dual temperature equipment or cold equipment containing fluids below ambient temperature with vapor retardant jackets.

P. For insulated equipment containing fluids above ambient temperature, provide jacket with or without vapor barrier.

Q. Cover insulation with aluminum jacket or stainless steel jacket. PVC covers are not acceptable.

R. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.

S. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage.

3.3 PIPING INSULATION SCHEDULE

A. Fiberglass Pipe insulation, ASTM C 547, Type 1

<table>
<thead>
<tr>
<th>Service and Fluid Temp</th>
<th>Pipe Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 and Less</td>
</tr>
<tr>
<td>Heating Systems - Steam, Steam Condensate 105-140 degrees F</td>
<td>1</td>
</tr>
<tr>
<td>141-200 degrees F</td>
<td>1.5</td>
</tr>
<tr>
<td>201-250 degrees F</td>
<td>1.5</td>
</tr>
<tr>
<td>251-350 degrees F</td>
<td>2</td>
</tr>
<tr>
<td>&gt;350 degrees F</td>
<td>2.5</td>
</tr>
<tr>
<td>Piping Exposed to Freezing All Sizes</td>
<td>1.5</td>
</tr>
</tbody>
</table>

B. Hydrous Calcium Silicate Insulation, ASTM C533, Type I

C. Insulate chilled water piping within 10 feet of steam tunnel or manhole.

3.4 STEAM TUNNEL AND STEAM MANHOLE INSULATION

A. Interior Top: 1 inch thick, rigid fiberglass board, ASTM C 612, Type 1A

B. Exterior Top: 1 inch thick, closed cell extruded polystyrene foam insulation; ASTM C 578 – 92, Type VI.

END OF SECTION 33 60 80
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Piping for Site Chilled Water Distribution
   2. Accessories

1.2 RELATED SECTIONS:

A. Section 31 23 33 – Trenching, Backfilling and Compacting.

B. Section 33 11 13 – Water Distribution Piping.

C. Section 03 30 53 – Cast-in-Place Concrete.

1.3 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI A21.10, Gray-Iron and Ductile-Iron Fittings, 3 inch through 48 inch, for Water and Other Liquids.
   4. ANSI A21.51, Ductile-Iron, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
   5. ANSI A21.53, Ductile-Iron Compact Fittings, 3 In. Through 24 In. (76 mm Through 610 mm) and 54 In. Through 64 In. (1,400 mm Through 1,600 mm) for Water Service.

B. American Society of Mechanical Professionals (ASME):
   1. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Professionals; 1998.
   3. ASME B31.9 - Building Services Piping; The American Society of Mechanical Professionals; 1996 (ANSI/ASME B31.9).

C. American Society for Testing and Materials (ASTM):

D. American Water Works Association (AWWA):
   2. AWWA C105, Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.
   3. AWWA C110, Gray-Iron and Ductile-Iron Fittings, 3 inch through 48 inch, for Water and Other Liquids.
5. AWWA C150, Thickness Design of Ductile-Iron Pipe.
6. AWWA C151, Ductile-Iron Pipe Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
7. AWWA C153, Ductile-Iron Compact Fittings, 3 In. Through 24 In. (76 mm Through 610 mm) and 54 In. Through 64 In. (1,400 mm Through 1,600 mm) for Water Service.
8. AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.

E. American Welding Society (AWS):
2. AWS D1.1 - Structural Welding Code - Steel; American Welding Society; 1996.

F. Manufacturer’s Standardization Society of The Valve and Fittings Industry:
2. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 1996.

1.4 SYSTEM DESCRIPTION

A. Chilled water distribution piping shall be capable of operation at not less than 150 psig and have a maximum working temperature of 75 degrees F.

B. General Requirements: Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
1. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
2. Use non-conducting dielectric connections whenever joining dissimilar metals in open systems.
3. Provide pipe hangers and supports in accordance with ASME B31.9 unless indicated otherwise.

C. Valving Requirements: The following requirements are general in nature; provide valves where indicated.
1. Use ball valves or gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
2. Use globe valves for throttling, bypass, or manual flow control services.
3. Use only butterfly valves in chilled and condenser water systems 4 inch and larger for throttling and isolation service.
4. Use lug end butterfly valves to isolate equipment.

1.5 SUBMITTALS

A. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
1. Manufacturer’s Installation Instructions: Indicate hanging and support methods, joining procedures.
2. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.


C. Project Record Documents: Record actual locations of piping and valves.

1.6 QUALITY ASSURANCE

A. Manufacturer's Experience: Company specializing in manufacturing products of the type specified in this section, with minimum five years of documented experience.

B. Ductile Iron Pipe: Test in accordance with AWWA C151 (ANSI A21.51).

C. Fittings: Test gray-iron and ductile-iron fittings in accordance with AWWA C110 (ANSI A21.10) and AWWA C153 (ANSI A21.53) Compact Fittings.

D. Installer Experience: Company specializing in performing work of the type specified in this section, with minimum five years of experience.

E. Welder Experience: Certify in accordance with ASME (BPV IX).
   1. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
   2. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

F. Regulatory Requirements: Conform to ASME B31.9 code for installation of piping system.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Transport, handle and store pipe materials, and other specified products, as recommended by respective manufacturers and supplemented in this Section, to prevent damage and defects.

B. Ship and transport valves to the site in shipping containers with labeling in place. Inspect for damage.

C. Storage: Store pipe and associated pipe fittings elevated off the ground with open ends capped or otherwise closed.
   1. Provide temporary protective coating on cast iron and steel valves.
   2. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
   3. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Keep trenches dewatered while installing pipe until required pipe joints are made and trench backfilled above water table.

B. Under no circumstances lay pipe in water or on bedding containing frost.

C. Do not lay pipe when weather conditions are unsuitable, as determined by Professional, for pipe laying work.
PART 2 - PRODUCTS

2.1 DUCTILE IRON PIPING FOR CHILLED WATER


B. Wall Thickness: Class 52, determined in accordance with AWWA C150 (ANSI A21.50), latest edition.

C. Joints: Provide fully restrained mechanical joints, conforming to applicable provisions of AWWA C111.

D. Interior Pipe Lining: Cement mortar lined in accordance with AWWA C104, double thickness, and bituminous seal coated in accordance with Section 4-11, Seal Coat, of AWWA C104. Provide NSF 61 approved seal coatings.

E. Exterior Pipe Coatings: Bituminous coating in accordance with Section 51-8, Coatings and Linings, AWWA C151.

F. Acceptable Manufacturers:
   1. American Pipe Co.
   2. Clow.
   3. Griffin.

G. Fittings: Ductile iron conforming to applicable provisions of AWWA C110 or ductile iron compact fittings conforming to AWWA C153; minimum working pressure rated at 250 psi.

H. Fittings to be mechanical or restrained joint conforming with applicable provisions of AWWA C111.

I. Fitting Lining: Cement mortar lined in accordance with AWWA C104, double thickness, and bituminous seal coated in accordance with Section 4-12, Seal Coat, of AWWA C104. Seal coatings NSF 61 approved.

J. Fitting Coatings: Standard bituminous coating in accordance with Section 51-8, Coatings and Linings, AWWA C151.

K. Joint Material for Ductile Iron Pipe or Fittings:
   1. Mechanical Joints, Ductile Iron Pipe and Fittings: Conforming to requirements of AWWA C111.
   2. Provide mechanical joints with retainer glands.

L. Mechanical Couplings: Gasketed, sleeve type with diameter to properly fit specified pipe. Couplings consist of one steel middle ring; two steel, malleable iron or ductile iron followers; two specially compounded rubber gaskets; and high strength low alloy steel bolting system suitable for coupling steel or ductile iron pipe.

M. Acceptable Manufacturers:
   1. Dresser Manufacturing Division Style 38 and 138; Transition Style 162.
   2. Smith Blair Product No. 411, transition product No. 413.

N. Wedge Action Retainer Glands:
1. Use fully restrained type joints on fittings and valves 4 inches through 48 inches diameter.
2. Retainer glands are not acceptable in lieu of restrained joints.
3. Mechanical joint retainer glands cast from ASTM A536, Grade 65-45-12 ductile iron. Wedging mechanism manufactured of ductile iron, heat treated to a hardness of 370 BHN minimum. Provide retainer glands with dimensions that can be used with standardized mechanical joint bell and tee head bolts conforming to requirements of AWWA C111 and AWWA C153. Wedge action screws incorporate twist off nuts in design to ensure proper torque. Provide mechanical joint restraining device for water working pressure rating of 250 psi minimum with a safety factor of at least 2:1.
4. Install mechanical joint retainer glands in accordance with manufacturer’s recommendations. Apply torque to T-bolts in accordance with manufacturer’s recommendations. Tighten torque limiting twist off nuts in alternate manner and clockwise direction. Apply joint deflection before T-bolts are torqued. Where retainer glands are used, limit joint deflection to 2-1/2 degrees maximum.

O. Acceptable Manufacturers:
1. EBAA Iron, Inc., Series 1100 (Megalug).
2. Ford Meter Box Co., Inc.; Series 1400 (Uni-Flange).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Carefully examine material for defects, and do not install material known to be defective.
B. Replace material found defective in manufacture or damaged in transit or handling at no additional expense.
C. Remove defective material from jobsite.
D. Rejected Products: Remove rejected Products from the Project site and replace with new Products at no increase in Contract Price.
1. Pipe already laid and later found defective will not be accepted and shall require its replacement.

3.2 PREPARATION

A. Verify that other site piping and building piping sizes, locations and inverts are as indicated.
B. Clean piping interior prior to laying pipe and following pipe laying and keep open ends of piping and pipe attachment openings capped or plugged until actual connection or actual pipe testing.
1. Provide protective means to prevent water and debris from entering pipe and fittings when not connected or left unobserved.
2. Cut pipe ends square, ream pipe ends to full pipe diameter, remove burrs. Bevel plain end ferrous pipe over 2 inches diameter. Thread ferrous pipe 2 inches diameter and under.
   a. Remove scale and dirt on inside and outside before assembly.
   b. Prepare piping connections with flanges and unions.
C. Earthwork: Perform earthwork for piping installation as specified in Section 31 23 33.
1. Bedding materials and concrete work for pipe bedding as specified in Section 31 23 33.
2. Excavate trenches in rock at least 25-feet in advance of pipe laying. Protect pipe ends from rock removal operations.
3. Establish elevations of buried piping to ensure not less than 48 inches of cover.

3.3 HANDLING OF PIPE AND FITTINGS

A. Unload, handle, and store ductile iron pipe, fittings, valves and appurtenances in accordance with AWWA C600. If damage or coating abrasion occurs and is deemed repairable, repair as directed by Professional in accordance with manufacturer’s recommendations. If damage is not repairable in opinion of Professional, reject pipe, fittings, valves or appurtenances, remove from Project site and replace at no additional expense.

B. Keep fittings and valves drained and stored before installation in a manner protecting them from damage due to freezing of trapped water.

3.4 INSTALLATION

A. General Requirements: Install the individual piping types in accordance with their respective manufacturer’s instructions.
   1. Install chilled water piping according to ASME B31.9 requirements.
   2. Lay and maintain pipe at required lines and grades as indicated on Drawings. Place fittings and valves at required locations with joints centered, spigots forced home, and valve stems plumb. Do not deviate from required line and grade, except with approval of Professional.
   3. Do not exceed allowable deflection at joints.
   4. Route piping in orderly manner, parallel to building structure, and maintain gradient. Slope piping and arrange to drain at low points.
   5. Install piping to conserve to avoid interference with other systems and Work.
   6. Sleeve pipe passing through walls and floors.
   7. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
   8. After completion of installations, clean, fill and treat the piping systems as required.
   9. Use eccentric reducers to maintain top of pipe level.
   10. Install hangers and supports in accordance with ASME B31.9.
   11. Close open ends of pipe with a watertight plug when pipe laying is not in progress.

3.5 THRUST RESTRAINT

A. General Requirements: Provide each non-restrained cap, tee, and bend (both horizontal and vertical) with thrust restraints as detailed on Drawings.

B. Concrete Reaction Backing: Place concrete reaction backing between undisturbed solid ground and fitting to be anchored. Locate backing, unless otherwise shown or directed, to contain resultant thrust force and so that pipe and fitting joints are accessible for repair.

3.6 FIELD QUALITY CONTROL

A. General Requirements: Conduct tests specified herein so that each pipe line installed in the Project is tested to the Professional’s satisfaction. Provide tools, materials, equipment, and instruments necessary for pipeline testing.

B. Perform hydrostatic pressure and leakage test, in accordance with Section 33 11 13 –Water System, and test criteria below. Care shall be taken to insure all trapped air is removed from the system prior to the test. Appropriate safety precautions shall be taken to guard against possible injury to personnel in the event of a failure. Test criteria:
1. Test pressure and duration: Test at 250 psig hydraulic pressure for a period of not less than two hours.
2. Allowable leakage rate: Not to exceed 10 Gallons/Inch Diameter/Mile/24 Hours.
3. Testing shall be witnessed by the University’s Representative, and results signed by University’s Representative.

C. Alternate Testing for Cold Weather
1. Pneumatic testing shall be performed in conformance with ANSI/ASME B31.9 and these criteria:
   a. Preliminary test: to 10 psig to check for major leaks.
   b. Cycle test: Gradually increase pressure to 125 psig, in stages of not more than 25% increments to allow for equalization of stresses and checking for leaks at each stage. Hold pressure of 125 psig for 10 minutes.
   c. Final test: Reduce pressure to 75 psig and conduct standing test for two hours with no loss in pressure, except for temperature compensation.

D. Repair and Retest: When section or sections of piping fails to meet specified requirements, determine source or sources of leakage, replace defective material and retest at no increase in Contract Price.

END OF SECTION 33 61 00
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The Work specified in this Section consists of constructing the compressed air distribution on site outside buildings.

1.2 RELATED SECTIONS:

A. Section 33 05 16 – Concrete Utility Structures

1.3 REFERENCES

A. American Society of Mechanical Professionals (ASME):
   1. ASME (BPV) - Boiler and Pressure Vessel Code; The American Society of Mechanical Professionals; 1998.
   5. ASME B31.9 - Building Services Piping; The American Society of Mechanical Professionals; 1996 (ANSI/ASME B31.9).

B. American Society for Testing and Materials (ASTM):

C. Manufacturer’s Standardization Society of The Valve and Fittings Industry:
   2. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 1996.

D. National Fire Protection Association (NFPA):

1.4 SYSTEM DESCRIPTION

A. Location: In steam tunnels and utility vaults.

B. Maximum Operating Pressure: 125 psig.

1.5 SUBMITTALS

A. Product Data: Provide manufacturers catalog literature with capacity, weight, and electrical characteristics and connection requirements.
1. Manufacturer’s Installation Instructions: Indicate manufacturer’s installation instructions, hoisting and setting requirements, starting procedures.
3. Warranty: Submit manufacturer warranty and ensure forms have been completed in Department’s name and registered with manufacturer.

B. Shop Drawings: Indicate piping system schematic with electrical characteristics and connection requirements.

C. Project Record Documents: Record actual locations of piping and components. Modify shop drawings to indicate final locations.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Pressure Vessels: Conform to applicable code for installation of pressure vessels.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Handling: Ship and transport pipe with end protectors in place. Inspect for damage.

B. Storage: Store pipe and associated pipe fittings elevated off the ground with open ends capped or otherwise closed.
   1. Protect piping and equipment from weather and construction traffic.

PART 2 - PRODUCTS

2.1 COMPRESSED AIR PIPE MATERIALS

A. Pipe and Fittings Materials, Above Grade and Inside Structures:
   1. Steel Pipe: ASTM A 53, Schedule 40 black, seamless or welded.

2.2 VALVES

A. Ball Valves:
   1. Acceptable Manufacturers:
      a. Apollo; Model 70-100, threaded.
   2. MSS SP-110, Class 150, 600 psi WOG, 316 Stainless Steel, two piece body, stainless steel ball, full port, teflon seats and stuffing box ring, blow-out proof stem, vinyl grip lever handle, threaded ends.

B. Quick Connector: 3/8 inch (10 mm) brass, snap on connector with self closing valve, Style A.

2.3 UNIONS AND COUPLINGS

A. Unions; Ferrous Pipe: 150 psi (1034 kPa) malleable iron threaded unions.
B. Dielectric Connections: Union with galvanized or plated steel threaded ends, with water impervious isolation barrier.

C. Flexible Connector: Neoprene with brass threaded connectors.

2.4 CONDENSATE DRAIN TRAPS

A. Provide automatic condensate drain, Spirax Model No. FA-30; Size 3/4 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that concrete utility tunnel and utility vault Work is complete and ready for pipe installation. See Section 33 05 16 for Concrete utility structures.

B. Verify that building service connection and pipe size, location and elevations are as indicated.

C. Field Inspection: Inspect each section of pipe and each pipe fitting for damage and defect before installation.

D. Verify that building service connection and pipe size, location and elevations are as indicated.

3.2 PREPARATION

A. General Requirements: Clean piping interior prior to laying pipe and following pipe laying and keep open ends of piping and pipe attachment openings capped or plugged until actual connection or actual pipe testing.
   1. Provide the protective means to prevent water and debris from entering pipe and fittings when not connected or left unobserved.

B. Cut pipe ends square, ream pipe ends to full pipe diameter, remove burrs. Bevel plain end ferrous pipe over 2 inches (50 mm) diameter. Thread ferrous pipe 2 inches (50 mm) diameter and under.
   1. Remove scale and dirt on inside and outside before assembly.
   2. Prepare piping connections with flanges and unions.

3.3 INSTALLATION

A. General Requirements: Install the individual piping types in accordance with their respective manufacturer’s installation instructions.
   1. Install air piping according to ASME B31.9 requirements. Identify piping system and components.
   2. Make pipe joints in accordance with the pipe manufacturer=s instructions.
   3. Route piping in orderly manner, parallel to building structure, and maintain gradient. Slope piping and arrange to drain at low points.
   4. Install piping to conserve building space and to avoid interfere with use of space.
   5. Sleeve pipe passing through partitions, walls and floors.
   6. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
   7. Install takeoff to outlets from top of main, with shut off valve after take off.
   8. Install valves with stems upright or horizontal, not inverted.
9. Installed compressed air couplings, female quick connectors, and pressure gages where outlets are indicated.
10. Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with a plug.

B. Pipe Hangers and Supports Installations: In general, install in accordance with ASME B31.9.
   1. Support horizontal piping as scheduled hereinafter.
   2. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
   3. Place hangers within 12 inches (300 mm) of each horizontal elbow.
   4. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   7. Provide enamel type finish coating on steel hangers and supports regardless of installation locations.
   8. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
   9. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
10. Cap and seal ends of piping when not connected to mechanical equipment.

3.4 SCHEDULES

A. Hanger Spacing for Steel Piping:
   1. 1/2 inch (15 mm), 3/4 inch (20 mm), and 1 inch (25 mm): Maximum span, 7 feet (2100 mm); minimum rod size, 1/4 inch (6 mm).
   2. 1-1/4 inches (32 mm): Maximum span, 8 feet (2400 mm); minimum rod size, 3/8 inch (9 mm).
   3. 1-1/2 inches (40 mm): Maximum span, 9 feet (2700 mm); minimum rod size, 3/8 inch (9 mm).
   4. 2 inches (50 mm): Maximum span, 10 feet (3.0 m); minimum rod size, 3/8 inch (9 mm).
   5. 2-1/2 inches (65 mm): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (9 mm).
   6. 3 inches (80 mm): Maximum span, 12 feet (3.6 m); minimum rod size, 3/8 inch (9 mm).

3.5 FIELD QUALITY CONTROL

A. General Requirements: Conduct tests specified herein so that each pipe line installed in the Project is tested to the Professional's satisfaction.

B. Compressed Air Piping Leak Test: Prior to initial operation, clean and test compressed air piping in accordance with ASME B31.9.
   1. Materials and Equipment: Provide tools, materials, apparatus and instruments necessary for pipeline testing.
   2. Test Pressures: Test all piping, regardless of location, to 100 psi for four (4) hours.
   3. Allowable Loss: Allowable pressure drop is zero, except for pressure drop due to temperature.

C. Repair and Retest: When Work fails to meet specified requirements, determine source or sources of leakage, repair or replace defective material and retest at no increase in Contract Price.
   1. Rejected Products: Remove rejected Products from the Project site and replace with new Products at no increase in Contract Price.
2. Pipe already laid and later found defective will not be accepted and shall require its replacement.

END OF SECTION 33 61 50
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The work specified in this Section consists of constructing the various types and sizes of precast concrete round shape manholes and cast-in-place concrete rectangular shape manholes required in the project.
   1. Includes the round shape precast concrete manholes for the sanitary sewer work.
   2. Includes the construction of cast-in-place concrete rectangular shape manholes for Mechanical work.
   3. Includes the construction of cast-in-place concrete rectangular shape manholes for Electrical work.

1.2 RELATED SECTIONS

A. Section 31 23 33 – Trenching, Backfilling and Compacting.
B. Section 33 05 16 – Precast Concrete Utility Structures.
C. Section 03 30 53 – Cast-in-Place Concrete.
D. Section 03 60 00 – Grout.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):
   4. ASTM A 615, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   5. ASTM C 144, Specification for Aggregate for Masonry Mortar.
   9. ASTM C 361, Specification for Reinforced Concrete Low-Head Pressure Pipe.
  11. ASTM C 478, Specification for Precast Reinforced Concrete Manhole Sections.
  15. ASTM D 2240, Test Method for Rubber Property-Durometer Hardness.

B. American Association of State Highway and Transportation Officials (AASHTO) Standards as referenced throughout these Specifications.

C. Federal Specifications:

1.4 SUBMITTALS

A. Shop Drawings and Product Data: Submit manufacturer's published detail drawings, modified to suit design conditions if required, catalog cuts, Contractor prepared drawings as applicable, and such other data as required to provide complete descriptive information for the following:
   1. Basic Materials.
   2. Precast Reinforced Concrete Manhole Components.

B. Certificates: Submit certified records or reports of results of shop tests with such records or reports containing a sworn statement that shop tests have been made as specified.
   1. Submit manufacturer's sworn certification that components and products will be manufactured in accordance with specified reference standards for components and products.
   2. Submit manufacturer's sworn certification that manhole frame and cover tensile test bars were poured from the same iron as castings they represent.

1.5 QUALITY ASSURANCE

A. Source Quality Control: Maintain uniform quality of products and component compatibility by using the products of one manufacturer for precast reinforced concrete manholes.
   1. Obtain certificate of materials and construction compliance with ASTM C 478 from the precast reinforced concrete manhole manufacturer. Submit this certificate as part of required submittals.
   2. Obtain certificate of material and construction compliance with ASTM A 48, Class 30 tensile strength from the manhole frame and cover manufacturer. Furnish certification that tensile test bars were from same pour as castings. Submit the certificate as part of required submittals.
   3. Shop and Laboratory Tests: As a condition of the Contract, the materials stated herein require periodic testing according to methods referenced, or as required by the Architect.
      a. Laboratory Tests: Submit three manhole frame and cover tensile test bars for each 50 manhole frames and covers or less if the total required is less than 50. Submit one machined test bar ready for testing. Architect will verify certifications, release one bar for the Machined Bar Tensile Test, and retain two remaining bars.
         1) Testing Laboratory shall furnish both Architect and Contractor two copies of test result reports. These reports will be considered as sufficient evidence of acceptance or rejection of materials represented.
      b. Shop Tests: The manhole component manufacturers shall have the capability to perform the number of tests that the Architect may require to establish the quality of the proposed manhole components. Manufacturers shall furnish to the Architect certified test records or reports with sworn statement of tests made as specified.
         1) Precast Reinforced Concrete Manholes: Conduct tests as specified in ASTM C 478.
         2) Manhole Frames and Covers: Test for AASHTO H-20 highway loading. Test one manhole cover of each design submitted for approval.

B. Certified Test Records: The Architect reserves the right to accept certified test records or reports of previously conducted tests.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Handling: Transport and handle precast reinforced concrete manhole components, and other products specified herein, in a manner recommended by their respective manufacturers to prevent damage and defects.
1. Through-wall lifting holes are not permitted in manhole component construction.

B. Storage: Store precast reinforced concrete manhole components in accordance with their manufacturer's recommendations to prevent joint damage and contamination. Exercise such care in storage of other specified products as recommended by their respective manufacturers.

1.7 SITE CONDITIONS

A. Environmental Requirements:
1. Do not set or construct manhole bases on subgrade containing frost.
2. To improve workability of Preformed Plastic Sealing Compound during cold weather, store such at temperature above 70 degrees F or artificially warm compound in a manner as recommended by the compound manufacturer.
3. During warm weather stiffen Preformed Plastic Sealing Compound by placing under cold water or by other means as recommended by the compound manufacturer.

PART 2 - PRODUCTS

2.1 BASIC MATERIALS

A. Cast-In-Place Concrete Products: As specified in Section 03 30 53.
1. Use Class A (4000 psi) quality concrete unless indicated otherwise on the Drawings.
2. Concrete formwork and reinforcement materials and fabrications are as specified in the referenced Sections in Section 03 30 53.

B. Non-Shrink Non-Metallic Grout: As specified in Section 03 60 00.

C. Waterproofed Mortar: Conforming to requirements of ASTM C 270 for Type M, 2500 psi. Parts by volume include: One part cement, 1/4 part lime, and sand at not less than 2-1/4 nor more than three times the sum of the volumes of cement and lime used and of the following materials:
1. Waterproofing Agent: Medusa Waterproofing Powder by Medusa Portland Cement Co.; Hydratite by Grace Construction Materials; or Hydrolox by Chem-Master Corp. Add the Medusa product in the ratio of two pounds per bag of cement; add the other products per manufacturer’s recommendations.
2. Portland Cement: Conforming to ASTM C 150, Type I.
3. Hydrated Lime: Conforming to ASTM C 207, Type S.
5. Water: Clean and free from deleterious amounts of acids, alkalis, and organic materials.

D. Epoxy Bonding Compound: Provide a high-modulus, low viscosity, moisture insensitive epoxy adhesive having the following characteristics.
1. Mix Ratio: 100 percent solids, two-component; mixed one part by volume component B to two parts by volume component A.
2. Ultimate Compressive Strength: 13,000 psi after cure at 73 degrees F and 50 percent relative humidity determined in accordance with ASTM D 695.
3. Acceptable Manufacturers:
   a. Sika Corporation: Sikadur Hi-Mod.
   b. Euclid Chemical Company; No. 452 Epoxy System.
   c. A. C. Horn, Inc.; Epoxite Binder.
   d. Or approved equal.
E. Manhole Steps: Manhole steps shall be provided only in the manholes where permitted by the Owner. The Contractor is permitted the option to provide one type of manhole step in the Project as selected from the step types and designs as specified herein. Only one type of step will be allowed within any one manhole.
   2. Reinforced Plastic Step: Composed of a ½ inch Grade 60, ASTM A 615 deformed steel reinforcing bar completely encapsulated in Grade 49108, ASTM D 4101 polypropylene copolymer compound, Type II; M. A. Industries, Inc., Type PS4, Or approved equal.

F. Manhole Frame and Cover (For Storm System): Gray iron castings conforming to ASTM A 48, Class No. 30, designed for AASHTO Highway Loading Class H-20. Provide castings of uniform quality, free from blowholes, porosity, hard spots, shrinkage distortion, or other defects. Frame and cover design and dimensions are as indicated on Drawings.
   1. Finish: Bearing surfaces machined to prevent rocking and rattling under traffic. Casting finished to meet AASHTO Specification M 306, 4.3.3 Painting, Welding, Plugging - Not Allowed.
   2. Identification: Cast the word STORM integrally on cover in two-inch size, raised letters.

G. Watertight Manhole Frame and Cover (For Sanitary Sewer): Gray iron castings conforming to specified requirements for Manhole Frame and Cover for Storm System with the addition of cover hold-down bolts.
   1. Cover Hold-down Bolts: Type 316 stainless steel conforming to ASTM A 276 for bolts and washers or manufacturer’s standard bronze bolts and washers.
   2. Identification: Cast the word SEWER integrally on cover in two-inch size, raised letters.
   3. O-ring Cover Gasket: One piece O-ring gasket factory installed in a machined rectangular or dovetail groove in the bearing surface of the cover.
      a. Gasket material of neoprene composition having good abrasion resistance, low compression set, Type D 40 durometer hardness determined in accordance with ASTM D 2240 and suited for use in sanitary sewer manholes.
      b. Gluing of gasket is not permitted.

H. Watertight Manhole Frame and Cover (For Electrical Manholes): Basic construction quality as specified above including cover hold-down bolts and O-ring gasket. Additional requirements as follows:

I. Manhole Component (Section-to-Section) Seals: The Contractor is permitted the option to provide one type of manhole component seal in the Project as selected from seal types specified herein except where required otherwise on the Drawings:
   1. Preformed Plastic Sealing Compound: Conforming to Fed. Spec. SS-S-210A, Type 1, Rope Form, of either bitumastic base compound or butyl rubber base compound and shipped protected in a removable two-piece wrapper.
      a. Dimensions: Size the cross-section of rope form to provide squeeze-out of material around entire interior and exterior circumference of each manhole section joint when joint is completed.
      b. Acceptable Manufacturers:
         1) K. T. Snyder Company, Inc.; RAM-NEK.
2) K. T. Snyder Company, Inc.; RUB'R-NEK.
3) Hamilton Kent Manufacturing Company; KENT-SEAL NO. 2.
4) Rubber Compression Gasket: Of material composition conforming to ASTM C 361 or ASTM C 443.

J. PVC Waterstop (For Connection to Existing Manholes): PVC waterstop for use for grouted connection of piping to existing manholes or for sewer pipe entering manhole bases of cast-in-place concrete construction.
   2. Acceptable Manufacturers:
      a. FERNCO Inc., CMA Concrete Manhole Adapter, Distributed by the General Engineering Company.
      b. Or approved equal.

K. Surface (Expanding-Type) Waterstop: Surface Waterstop for use for pipe diameters larger than 24 inches connecting into manhole bases of cast-in-place concrete construction.
   1. Material Composition: A specially formulated joint sealant which swells on contact with water. Provide waterstop packaged in continuous length coils. Sealant composed of chloroprene rubber and chloroprene rubber modified to impart hydrophilic properties.
      a. Waterstop shall have a coating formulated to inhibit initial expansion due to moisture presence in the fresh concrete.
      b. Waterstop configuration shall be of dual extrusion design and 10 mm by 20 mm dimensions.
      c. Waterstop shall be secured to hardened concrete with the waterstop manufacturer’s standard adhesive binder.
   2. Acceptable Manufacturers:
      a. Greenslack, Inc.; Hydrotite VCJ.
      b. Or approved equal.

2.2 PRECAST REINFORCED CONCRETE MANHOLE COMPONENTS

A. Materials and Fabrication: Conforming to requirements specified in ASTM C 478 except as follows:
   1. Concrete: Composition and compressive strength conforming to ASTM C 478 except use Type II or Type III cement in manhole components and increase compressive strength to 4500 psi (at 28 days) in precast bases.
   2. Casting and Curing: Wet cast and steam curing process in accordance with Section 3.6.11 and 3.7.2 of AWWA C 302.
   3. Manhole Steps: Factory installed in manhole components, prealigned vertically, spaced on equal centers, and located the minimum distance from ends of risers and top sections as indicated on Drawings.
   4. Manhole Component Seals: As specified previously. Manhole component joints factory formed for self-centering concrete to concrete bearing employing either a rubber compression gasket or preformed plastic sealing compound.
   5. Manhole Component Design: Designs shall conform to ASTM C 478. Base, tapered and straight riser section, and top section dimensions and diameters, not consistent with ASTM C 478, are as indicated on Drawings.

B. Precast Base and Riser Sections: Design, materials and construction as specified previously under Materials and Fabrication.
1. Large Diameter Pipe Base (Doghouse Style): Precast base section designed to fit over large diameter pipes allowing the construction of the bottom portion (slab) of the base to be poured-in-place around and under the pipe. Construct the poured-in-place portion in accordance with the requirements specified hereinafter for Cast-In-Place Concrete Manhole Base.

C. Prefabricated Pipe Openings: Provide precast base sections with custom preformed pipe openings with integral pipe seals. Preform the pipe opening to accommodate the type of pipe and pipe opening seal required.

1. Prefabricated Pipe Opening Seals: Resilient gaskets of the types and designs which conform to the requirements specified in ASTM C 923.

D. Precast Top Sections: Designs as required by the Drawings, and of materials and construction as specified herein, except additional and differing requirements as follows:

1. Hold Down Bolt Inserts: Factory cast the inserts in the top section with no fewer than two 3/4-inch threaded inserts or slotted inserts to accommodate manhole frame hold down bolts. Provide threaded inserts of three-inch depth and designed for an ultimate load in tension of 12,500 pounds. Inserts factory plugged for shipping. Coordinate insert locations in the top sections to match the bolt hole locations in the manhole cover frames.

2. Flat Slab Tops: Thickness versus diameter is as indicated on the Drawings. Tops factory formed to properly accept and support required manhole cover frame and properly formed underside to join the top section to the riser section in a matching joint.

3. Eccentric Cone Tops: Provide precast tops of the same minimum wall thickness and with same area of circumferential steel reinforcement as riser sections.

E. Precast Grade Rings: Provide one-piece design (two-piece design not acceptable) precast concrete leveling and adjusting units of three-inch or four-inch thickness, and of materials and construction as specified previously under Materials and Fabrication.

1. Provide precast grade rings with hold down bolt holes matching location of bolt holes in the cast iron manhole cover frame.

2. The grade ring design shall provide for full bearing of the cast iron manhole cover frame.

F. Waterproof Coating: Provide asphalt compound coating of either the solvent type or the emulsion type. However, mixtures of the two types in the Project are not permitted.

1. Solvent Type: Brush or spray-on asphalt compound, cold-applied and conforming to Federal Specification SS-A-701 B.

2. Emulsion-Type: Brush or spray-on asphalt-base, clay emulsion with fibers, cold-applied and conforming to Federal Specification SS-R-1781.

3. Acceptable Manufacturers:
   a. W. R. Meadows, Inc.; SEALMASTIC.
   b. Cooper Creek.
   c. Or approved equal.

4. Application: The coating may be either shop or field applied. Apply coating to the exterior of manhole components.
   a. Apply coating in two coats at the rate of 75 to 100 square feet per gallon per coat. Allow 24 hours drying between coats.

PART 3 - EXECUTION
3.1 **EXAMINATION**

A. **Field Inspection:** Inspect precast reinforced concrete manhole components in accordance with requirements of ASTM C 478 regarding repairable defects and defects subject to rejection by the Architect.

3.2 **PREPARATION**

A. **Earthwork:** Perform earthwork for manhole installation as previously specified in Section 31 23 33 and according to the following:
   1. **Protection:** During the earthwork operations, keep pipe and manhole interiors cleared of debris as construction progresses.

B. **Waterproof Coating Touch-Up:** Touch-up chipped, cracked, or abraded surfaces and finished joints with two coats of the factory applied waterproof coating material.
   1. Bring coating materials for touch up and field coating to the job site in the original sealed and labeled containers of the manufacturer.

3.3 **MANHOLE CONSTRUCTION METHODS**

A. **Cast-In-Place Concrete (Rectangular Shape) Manhole Construction:** Construct manholes in accordance with design and dimensions indicated on Drawings.
   1. Form and pour concrete in accordance with requirements of Section 03 30 53. Additional requirements as follows:
      a. Vibrate poured concrete using mechanical vibrator of a type and design approved by Architect. Use vibrators of type capable of transmitting vibration to concrete in frequencies of not less than five thousand impulses per minute.
   2. Install piping or conduits in cast-in-place manhole construction prior to pouring the concrete.
      a. Apply Epoxy Bonding Compound in accordance with manufacturer’s instructions to pipe at base connection prior to pouring the concrete.
      b. Install PVC Waterstop on individual pipes or conduits entering and leaving manhole base prior to pouring concrete. Install PVC Waterstop in accordance with manufacturer’s written instructions.
   3. Use Class A (4000 psi) concrete as specified in Section 03 30 53, unless indicated otherwise on Drawings.

B. **Precast Concrete Round Manhole Base Installation:** Install precast base on a 6-inch deep compacted layer of aggregate meeting requirements of Pipe Zone Bedding as specified in Section 31 23 33.
   1. Set pipe in the Prefabricated Pipe Opening Seals so that an equal annular space is created on the interior and exterior of the wall of the manhole base section.
   2. Following pipe installation through the seal, grout the annular space at the pipe connection, on both sides of the wall, to the spring line of the pipe. Finish the grout smooth and flush with face of manhole.

C. **Large Diameter Pipe Base (Doghouse Style) Round Precast Manhole Base Installation:** Pipes entering the precast base shall be sealed into the grout in-fill with Surface (Expanding Type) Waterstop. Install the waterstop material to be centered within the wall thickness of the base wall.
   1. **Waterstop Installation:** Install the Surface (Expanding Type) Waterstop on the pipe and in accordance with manufacturer’s recommendations and the following:
      a. Install the waterstop on properly prepared substrates and in accordance with the environmental requirements stated in the manufacturer’s instructions.
      b. Prime the joining surfaces if required by the waterstop manufacturer’s instructions.
2. Grout Installation: Install the Non-Shrink Non-Metallic Grout to fill the annular space between the pipe and the base section. Trowel the finished grout installation smooth and flush with the riser section surfaces, both inside and outside.

D. Length of Pipe Connections into Manholes: Use pipes no longer than five feet in length when connecting into manholes through Prefabricated Pipe Opening Seals.
1. For other types of pipe connections into manholes, use pipes of such length that a pipe joint is provided at the outside edge of manhole base or wall as applicable. Also use pipes no longer than 6 feet in length for first pipe joined thereto.

E. Concrete Channel Fill In Sanitary Sewer Runs: Field pour and form concrete channel fill for each manhole base except in the case where precast bases are used, factory preformed channels may be provided.
1. Form inverts directly in concrete channel fill.
2. Accurately shape invert to a semi-circular bottom conforming to inside of connecting pipes, and steel trowel finish to a smooth dense surface.
3. Make changes in size and grade gradually.
4. Make changes in direction of entering sewer and branches to a true curve of as large a radius as manhole size will permit.
5. In terminal manholes, install concrete channel fill with formed channel extending from downstream pipe opening directly across the base to future pipe opening on upstream side of the base.
6. Make slopes gradual outside the invert channels.
7. Use Class B (3000 psi) concrete as specified in Section 03 30 53, unless indicated otherwise on Drawings.
8. When precast bases with preformed channels are used, fill the annular space at the pipe connections on both sides of the wall to assure flow through the channel and bring grout up to the spring line of the pipe.
9. Use Non-Shrink Non-Metallic grout as specified in Section 03 60 00.

F. Precast Concrete Manhole Wall Section Installation: Provide precast reinforced concrete straight riser, tapered riser and top sections necessary to construct complete manholes. Fit the different manhole components together to permit watertight jointing and true vertical alignment of manhole steps.
1. If rubber compression gaskets are used between sections, install gaskets and join sections in accordance with written instructions of manhole component manufacturer.
2. If Preformed Plastic Sealing Compound is used between sections, install sealing compound in accordance with manufacturer's recommendations, and join sections in accordance with written instructions of manhole component manufacturer.
   a. Prime joint surfaces if required by sealing compound manufacturer.
   b. If sealing compound is installed in advance of section joining, leave exposed half of two-piece protective wrapper in place until just prior to section joining.
   c. Use sealing compound as the sole element utilized in sealing section joints from internal and external hydrostatic pressure.
   d. Arrange and pay for the sealing compound manufacturer's representative to be present for first installation of manhole sections to instruct workmen on proper installation methods of sealing compound and to be present while manhole sections are being installed.
   e. Following manhole section installation, trowel sealing compound surface smooth and flush with interior face of manhole.
   f. Make pipe connections into manhole walls as specified for pipes connecting into manhole bases.

G. Lifting Recess Sealing: Seal lifting recesses is precast concrete manhole sections with properly designed tapered rubber plugs. Drive plugs into recesses in such manner to render them completely water and air tight. Sealing of lifting recesses with grout not permitted.
H. Cast Iron Manhole Frame and Cover Installation: Where required, make final adjustment of cast iron frame to proper elevation using Grade Rings. Set manhole frame and cover to conform to roadway grade and crown (if any). Set top of manhole frame and cover 1/2-inch below finished paving elevation.

1. Precast Concrete Grade Ring: Wet, but do not saturate, the grade rings immediately before laying. Pre-set grade rings to proper plane and elevation using wedges or blocks of cementious material not exceeding the joint thickness. No more than four wedges or blocks per grade ring permitted. Incorporate wedges or blocks in fresh mortar in a manner to completely encase each. Mortar thickness not to exceed 3/4-inch maximum and 3/8-inch minimum. Crown fresh mortar to produce squeeze-out between grade rings. Tool exposed joints with appropriately shaped tool and compact mortar edge into joints. Clean off excess mortar prior to initial mortar set.

2. Cast Iron Manhole Frame and Cover Anchorage: Anchor manhole frames in place on manhole top section, or on leveling units, after installing ½-inch thick preformed plastic sealing compound on bearing surface of manhole frame. Remove excess sealing compound squeeze-out after manhole frame is bolted in place.

   a. Anchor Bolt Length: Size bolts according to the following:
      1) Sufficient length to properly pass through leveling units (if any).
      2) Sufficient length to engage full depth of manhole top section inserts.
      3) Sufficient length to allow enough threaded end to pass through manhole frame to properly tighten nut and washer.

   b. Tighten manhole frame bolts after mortar has cured.

   c. Install manhole covers using the proper bolts as provided with the covers for the waterproof installations.

3.4 INTERFACING EXISTING SEWER

A. Bypass Provisions: As work of this Section, maintain flow in the existing sewer both during construction operations and until concrete is cured, both in the case of cast-in-place work and newly formed invert channels.

   1. Provide a fail-safe (and properly sized) temporary means and methods of continued wastewater system service. The means and methods are at the Contractor’s discretion.
   2. Do not permit ground or surface water to enter the existing wastewater sewer facilities during the construction or the bypass work.
   3. Do not flush or drain water, or deposit debris from the new manhole construction, into the existing wastewater sewer facilities.

B. Constructing Manholes on Existing Sewer: Where new manholes are constructed on existing sewers, the Contractor shall have the option to construct the specified cast-in-place manhole bases or precast manhole bases. In either case, make the appropriate connection of the new and existing sewer pipe to the new manhole.

   1. Where the invert difference between the new and existing sewer is two feet or more, construct a drop manhole base. No separate or additional payment will be made for the vertical feet of drop connection required.
   2. Where the existing piping is damaged beyond the new manhole base as a result of work of constructing the new manhole, replace such damaged pipe with new to the first joint or to such point as agreed to by the Architect.
   3. Where precast manhole bases are used, replace the existing sewer pipe with new to the first joint outside the manhole base.
   4. Where cast-in-place manhole bases are constructed, saw-cut the existing piping to be removed. Chipping or breaking pipe as a cutting method is not acceptable.
   5. Following the manhole base construction, install a watertight pipe plug until debris and accumulated water have been removed from the new manhole base and the new sewer facilities have passed the specified acceptance tests.

3.5 FIELD QUALITY CONTROL
A. General Requirements: For those manholes required to be watertight, conduct tests as specified herein and in the presence of, and to complete satisfaction of, the Architect. Should a manhole not satisfactorily pass testing, discontinue manhole construction in the Project until that manhole does test satisfactorily.

1. Provide tools, materials, equipment, and instruments necessary to conduct the manhole testing specified herein.
   a. Vacuum Testing Equipment: Use vacuum apparatus equipped with necessary piping, control valves and gauges to control air removal rate from the manhole and to monitor vacuum.
      1) Provide an extra vacuum gauge of known accuracy to frequently check test equipment and apparatus.
      2) Vacuum testing equipment and associated testing apparatus are subject to Architect's approval.
      3) Provide seal plate with vacuum piping connections for inserting in manhole frame.

2. Prior to testing, clean manholes thoroughly and seal openings, both to the complete satisfaction of the Architect. Seal openings using properly sized plugs.

3. Perform testing with the cast iron frames and covers installed. Include the joint between the precast manhole component and the cast iron manhole frame in the test.

4. The Contractor may elect to make a test for his own purposes prior to backfilling. However, conduct tests of the manholes for acceptance only after the backfilling has been completed.

5. If a manhole is constructed on an existing active sanitary sewer, where sewage flow must be maintained, the test will be waived.

B. Vacuum Test Procedure: Perform vacuum testing in accordance with the testing equipment manufacturer's written instructions and the following:

1. Draw a vacuum of ten inches of mercury and close the valves.

2. Consider manhole acceptable when vacuum does not drop below nine inches of mercury for the following manhole sizes and times:
   a. Four foot diameter - 60 seconds.
   b. Five foot diameter - 75 seconds.
   c. Six foot diameter - 90 seconds.
   d. Seven foot diameter - 105 seconds.

C. Repair and Retest: Determine source or sources of leaks in manholes failing acceptable limits.

1. Repair or replace defective materials and workmanship, as is the case, and conduct such additional Manhole Acceptance Tests and such subsequent repairs and retesting as required until manholes meet test requirements.

2. Materials and methods used to make manhole repairs shall meet with Architect's approval prior to use.

3. Make repairs, replacements, and retests at no increase in Contract Price.

END OF SECTION 33 62 50
PART 1 - GENERAL

1.1 SUMMARY

A. SECTION INCLUDES
   1. Pipe and pipe fittings.
   2. Valves.
   3. Steam piping system.
   4. Steam condensate piping system.
   5. Steam traps.
   7. Accumulators and Flash Tanks.
   8. Air Powered Condensate Pump.

1.2 RELATED SECTIONS

A. Section 33 05 16 – Concrete Utility Structures.

B. Section 31 23 33 - Trenching, Backfilling and Compaction.

C. Section 03 30 53 - Cast-In-Place Concrete.

1.3 REFERENCES

A. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 1998.


E. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 1996 (ANSI/ASME B31.9).


O. AWS D1.1 - Structural Welding Code - Steel; American Welding Society; 1996.


Q. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 1996.


1.4 SYSTEM DESCRIPTION

A. High Pressure Steam (HPS): Maximum operating pressure 250 psig.

B. Low Pressure Steam (LPS): Maximum operating pressure 15 psig.

C. Condensate Return (CR, PC, GC): Maximum operating pressure 125 psig, 212 degrees F.

D. For steam and condensate piping in manholes and structures, use steel carrier pipe, high temperature insulation, and aluminum jacket.

E. When more than one piping system material is selected, ensure systems components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.

F. Use unions, flanges, and downstream of valves and at equipment or apparatus connections. Use dielectric unions where joining dissimilar materials. Do not use direct welded or threaded connections.

G. Provide inserts, anchors, pipe hangers and supports in accordance with ASME B31.9 unless indicated otherwise.

H. Use stainless steel ball valves for shut-off and to isolate equipment, parts of systems, or vertical risers for pipe sizes up to and including three inches. For pipe sizes over 3 inch, use butterfly valves.

I. Use stainless steel globe valves, ball valves or butterfly valves for throttling, bypass, or manual flow control services for pipe sizes up to and including three inches. For pipe sizes over 3 inch, use butterfly valves.

J. Use Balanced Pressure Thermostatic Steam Traps for:
1. Main steam headers

1.5 PERFORMANCE REQUIREMENTS

A. Steam Traps:
   1. Select to handle minimum of two times maximum condensate load of apparatus served.

B. Pressure Differentials:
   a. Low Pressure Systems (15 psi (103 kPa) maximum): 2 psi (13.8 kPa).
   b. High Pressure Steam (125 to 250 psi (1034 kPa) maximum): 40 psi (276 kPa).

1.6 SUBMITTALS

A. Product Data:
   1. Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
   2. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
   3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each specialty.
   4. Include electrical characteristics and connection requirements.


C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

D. Project Record Documents: Record actual locations of piping and valves.

E. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.7 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the type of products specified in this section, with minimum five years of documented experience.

B. Installer: Company specializing in performing the work of this section, with minimum five years of documented experience.

C. Welders: Certify in accordance with ASME (BPV IX).

1.8 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 and ASME B31.1 code for installation of piping system.

B. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

C. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

D. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose indicated.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.10 EXTRA MATERIALS

A. Provide two repacking kits for each size and valve type.

B. Provide two service kits for each size and type of steam trap.

PART 2 - PRODUCTS

2.1 LOW PRESSURE STEAM PIPING 15 PSIG (103 KPA) MAXIMUM

A. Steel Pipe: ASTM A 53, Schedule 40, black.
   2. Joints: Threaded up to 2 inch, AWS D1.1, welded for larger than 2 inch.

2.2 STEAM CONDENSATE PIPING – ABOVE GRADE AND IN MANHOLES

A. Steel Pipe: ASTM A 53, Schedule 80, black.
   1. Fittings: ASME B16.3 malleable iron Class 125, or ASTM A 234/A 234M forged steel.
   2. Joints: Threaded up to 2 inch, AWS D1.1, welded for larger than 2 inch.

2.3 FRP CONDENSATE CARRIER PIPING UNDERGROUND

A. FRP Pipe and Fitting Materials Sizes 1-14 inches, Direct-Buried.
   1. Pipe Construction:
      a. The structural wall of fiberglass pipe shall have glass fibers in a matrix of cured epoxy resin.
      b. The integral, reinforced resin-rich liner shall consist of glass and a resin/hardener system identical to that of the structural wall, and shall have a 60 mil nominal thickness. Non-reinforced pure resin-type corrosion barriers (liners) shall not be allowed due to their potential for severe fracturing during transportation, installation, and operation of the pipe.
      c. Pipe shall be manufactured according to ASTM D-2997, RTRP, Type II, Grade 1 Class C specification for Reinforced Thermosetting Resin Pipe (RTRP).
      d. Epoxy fiberglass pipe shall be translucent to all for inspection of damage.
      e. Pipe in 2 through 8-inch sizes shall be furnished in 30 or 40 foot length to minimize the number of field–bonded joints for rapid installation.
   2. Standard Fitting Construction:
      a. Fittings in 1 through 14-inch sizes shall be filament wound with a reinforced resin-rich liner of 60 mil minimum thickness and of the same glass and resin type as the pipe. Pipe, fittings, and adhesive shall, as an assembly, provide a continuous liner throughout the system.
      b. Compression-molded fittings in 2, 3, 4 and 6-inch nominal sizes may also be allowed upon agreement between purchaser and manufacturer.
c. Contact-molded spray or hand-layup fittings are not allowed.

3. Workmanship:
   a. The pipe and fittings shall be free from all defects, including delaminations, indentations, pinholes, foreign inclusions, bubbles, and resin-starved areas which, due to their nature, degree or extent, detrimentally affect the strength and serviceability of the pipe or fittings. The pipe and fittings shall be as uniform as commercially practicable in color, density and other physical properties.

4. Testing
   a. Samples of pipe and couplings shall be tested at random, based on standard quality control practices to determine conformance of the materials to American Society for Testing and Materials guidelines for testing fiberglass pipe products:
   b. Test samples may be hydrostatically tested by the manufacturer to 1.5 times the pressure rating for signs of leakage.

5. Field Testing
   a. Piping systems are designed for hydrostatic field testing at 150 percent of rated operating pressure. Pneumatic testing is not recommended.

6. Manufacturer:
   a. Fibercast - Centricast Plus RB-2530

2.4 PIPE HANGERS AND SUPPORTS

A. Conform to ASME B31.9.

B. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch (13 to 38 mm): Malleable iron, adjustable swivel, split ring.

C. Hangers for Pipe Sizes 2 to 4 Inches (50 to 100 mm): Carbon steel, adjustable, clevis.

D. Hangers for Pipe Sizes 6 Inches (150 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.

E. Multiple or Trapeze Hangers for Pipe Sizes to 4 inches (100 mm): Steel channels with welded spacers and hanger rods.

F. Multiple or Trapeze Hangers for Pipe Sizes 6 Inches (150 mm) and Over: Steel channels with welded spacers and hanger rods; cast iron roll and stand.

G. Wall Support for Pipe Sizes to 3 Inches (70 mm): Cast iron hook.

H. Wall Support for Pipe Sizes 4 to 5 Inches (100 to 125 mm): Welded steel bracket and wrought steel clamp.

I. Wall Support for Pipe Sizes 6 Inches (150 mm) and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll.

J. Vertical Support: Steel riser clamp.

K. Floor Support for Pipe Sizes to 4 Inches (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

L. Floor Support for Pipe Sizes 6 Inches (150 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

M. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
N. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.5 UNIONS, FLANGES, AND COUPLINGS

A. Unions for Pipe 2 Inches (50 mm) and Under:
   1. Ferrous Piping: 150 psig (1034 kPa) galvanized malleable iron, threaded.

B. Flanges for Pipe Over 2 Inches (50 mm):
   1. Ferrous Piping: 150 psig (1034 kPa) forged steel, slip-on.
   2. Gaskets: 1/16 inch (1.6 mm) thick preformed non-asbestos graphite fiber.

C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

D. Flange isolation kits: cathodic protection for installation in steam mains as indicated on the drawings.
   1. Requirements: 250psi steam system operation.
   2. Components:
      a. Steel washer.
      b. Insulating washer.
      c. Bolt sleeve.
      d. Flange gasket.
   3. Acceptable Manufacturers:
      a. PSI, Inc.

2.6 STEAM SERVICE VALVES

A. Manufacturers:
   1. Adams.
   2. Tricentric.
   4. Vanessa.

B. Triple offset butterfly valve.

C. Valves performance characteristics as listed below:
   1. Service: Steam
   2. Working pressure, max., psig: 250.
   3. Temperature range, F: 375.
   5. Valves shall be rated for bubble tight shutoff.

D. Construction
   1. Size, in.: 3 in. through 10 in.
   2. Body type: Flanged, ANSI Class 150.
   3. Body material: Carbon steel, ASTM A-216, grade WCB.
   7. Seat: Graphite/stainless steel laminate.
   8. Epoxy finish.
2.7 CONDENSATE SERVICE BUTTERFLY VALVES

A. Manufacturers:
   2. Jamesbury.
   3. Crane.

B. High performance butterfly valve, lever operated, lug mounting, ASME Class 150

C. Construction:
   1. Carbon steel body ASTM A216
   2. 316 Stainless steel disk ASTM A564
   3. 17-4 PH Stainless Steel ASTM A564 Gr 630
   4. PTFE Packing

2.8 STAINLESS STEEL BALL VALVES

A. Service: Steam Condensate

B. Up To and Including 2 Inches:
   1. Stainless steel two piece body, ball, stem, and lever handle.
   2. RPTFE packing and seats and stuffing box ring, threaded ends.

C. Manufacturer:
   1. Conbraco Industries Inc., Apollo 76-100 Series Stainless Steel Ball Valves.

2.9 STAINLESS STEEL CHECK VALVES

A. Up to and including 3 Inches:
   1. Stainless steel body and trim, rotating swing disc or wafer style with Teflon seat, threaded ends.

B. Manufacturer:
   1. Red – White Valve Co., Figure 884.

2.10 PRESSURE DRIVEN CONDENSATE PUMP

A. Acceptable Manufacturers:
   1. Spirax Sarco.
   2. Armstrong Intl, Inc.
   3. Or approved equal.

B. Body shall be constructed of cast iron, ASTM A 216 with all stainless steel internals. Single compression springs shall not be accepted. Motive and vent connections shall have externally replaceable seats for viewing and inspecting the internal valves.

C. Motive Force: Compressed air.

D. Pumps shall require no electricity for operation.

E. The Pump shall include a bronze water level gauge with shut off valves.

F. Overall height of the pump shall not exceed 28 inches.

G. Condensate inlet and outlet connections.
H. Check valves shall be either bronze or stainless steel.

2.11 FLOAT AND THERMOSTATIC TRAPS

A. Manufacturers:
1. Spirax-Sarco FTGS43 – 1 Inch.
2. MEPCO (Marshall Engineered Products Co.).

B. Construction: Austenitic stainless steel body ASTM A351, stainless steel internal parts.

C. Differential Pressure: 4.5 bar.

D. Maximum working pressure: 232 psig at 450 deg. F.

2.12 THERMAL EXPANSION JOINT

A. Manufacturers:
2. No substitutes.

B. Internal and external guides and designed for the injection of self-lubricating packing under full line pressure. A 2 inch diameter minimum type A packing cylinder shall be welded in place and shall have internal acme threads to assure maximum evacuation of the injectable packing from the packing cylinder. Integral anchor base.

C. Construction:
1. Traverse chamber and stuffing box shall be seamless steel A-53 Gr B pipe or equivalent tubing with circumferential weld attachments of the butt type only.
2. Slip shall be machined from A-53 Gr B seamless pipe. Slip shall be coated with Corro-Cote Plus Plating a duplex chrome plate consisting of 1 mil of hard chrome applied over 1 mil of crack-free hard chrome and certified by permascope inspection per ASTM standard B-499.

D. Stuffing Box:
1. The stuffing box packing area in contact with the sliding slip shall be at least 15 times the expansion joints nominal pipe size
2. Stuffing box injectable packing shall be Type H for operating temperatures to 550F
3. Internal and external guide surfaces in contact with chrome-plated slip shall be furnished with BRONZALON low friction inserts to prevent scoring or binding of the sliding slip.

E. Type/Traverse:
1. Expansion joints shall be single or double type with anchor base. Each slip has a nominal traverse of 8”.
2. Expansion joints shall be designed to 150 psi with welded ends.

F. Insulation: Provide insulating blanket with flange and packing box access. Blanket should be for use in man-hole applications.

G. Performance: It shall be the installer’s responsibility to make final connections and verify free movement from installed pipe temperature to minimum and maximum temperature.
1. The joint will be cycled a minimum of 3 times through the rated travel to ensure free movement and verify the proper amount of packing is injected. Each joint shall be preset with 1” movement in extension and the nominal traverse in compression.
2.13 BELLOWS EXPANSION JOINT (FOR FRP TO STEEL PIPE TRANSITION)

A. Manufacturer:
1. Flexicraft Flextra 150.

B. Bellows style rubber expansion joint capable of lateral and axial motion with 150# flanges.
1. Bellows manufactured of EPDM with polyester or nylon reinforcement.
2. Safety factor of 4:1 for pressure rating.
3. Flanges to conform to ANSI dimensions.
5. Lateral motion: ¾ inches.

2.14 PREFABRICATED PIPE ANCHORS

A. Manufacturers:

B. Pre-fabricated, pre-engineered pipe anchors, welded pipe connections, gauge thickness to match piping system.

C. Anchors are to be constructed of A36 and A106 carbon steel.

D. Pipe anchors are to be designed to withstand the forces from pressure thrust, friction force of packed expansion joints, and friction force from guides and supports depending on the application.

2.15 STEAM AIR VENTS

A. Manufacturers:
3. Spirax-Sarco.

B. 125 psi (860 kPa)
1. Balanced Pressure Type: Cast brass body and cover; access to internal parts without disturbing piping; stainless steel bellows, stainless steel valve and seat.

C. 225 psi (1550 kPa)
1. Balanced Pressure Type: ASTM A 126 cast iron body and cover; access to internal parts without disturbing piping; phosphor bronze bellows, stainless steel valve and seat.

2.16 ACCUMULATORS AND FLASH TANKS

A. Manufacturers:
1. Adamson Global Technology Corp.
2. Weben Jarco, Inc.
3. Wessels Company.

B. Tank:
1. Closed type, tested and stamped in accordance with ASME (BPV VIII, 1) welded steel construction, cleaned, prime coated, and supplied with steel support legs or wall bracket.
3. Construct with nozzles and tappings for installation of accessories and piping connections.
PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and dirt on inside and outside before assembly.
C. Prepare piping connections to equipment with flanges or unions.
D. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.
E. After completion, fill, clean, and treat systems.
F. Schedule and coordinate shutdown of steam, condensate, and compressed air system with the University Office of the Physical Plant prior to installation.

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.
B. Route piping in orderly manner, plumb and parallel to buildings and structures, and maintain gradient. Do not block access or vent manholes.
C. Install piping to conserve building space and avoid interference with use of space.
D. Sleeve pipe passing through partitions, walls, and floors.
E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
F. Anchor Blocks: See Section 03 30 53 – Cast-in-Place concrete.
G. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (100 mm).
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below, and provide through-bolt with recessed square steel plate and nut above slab.
H. Pipe Hangers and Supports:
   1. Use minimum of ½ inch diameter anchor bolts
   2. Install in accordance with ASME B31.9.
   3. Support horizontal piping as scheduled.
   4. Place hangers within 12 inches (300 mm) of each horizontal elbow.
   5. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Provide copper plated hangers and supports for copper piping.
9. Prime coat exposed steel hangers and supports. Refer to Section 09900. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

I. Provide clearance for installation of insulation and access to valves and fittings.
J. Unless otherwise indicated, slope steam piping one inch in 40 feet (0.25 percent) in direction of flow. Use eccentric reducers to maintain bottom of pipe level.
K. Unless otherwise indicated, slope steam condensate piping one inch in 40 feet (0.25 percent). Provide drip trap assembly at low points and before control valves. Run condensate lines from trap to nearest condensate receiver. Provide loop vents over trapped sections.
L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
M. Install valves with stems upright or horizontal, not inverted.
N. Install specialties in accordance with manufacturer's instructions.
O. Steam Traps:
1. Provide minimum 3/4 inch (20 mm) size on steam mains and branches.
2. Install with union or flanged connections at both ends.
3. Provide gate valve and strainer at inlet, and gate valve and check valve at discharge.
4. Provide minimum 10 inch (250 mm) long, line size dirt pocket between apparatus and trap.
5. Remove thermostatic elements from steam traps during temporary and trial usage, and until system has been operated and dirt pockets cleaned of sediment and scale.
6. In high pressure and medium pressure mains, provide 3/4 inch (20 mm) nipple in bottom of main, extending 3/4 inch (20 mm) into and above bottom of pipe. Provide dirt pocket with 1/2 inch (13 mm) high pressure thermostatic trap.

3.3 TESTING OF STEAM DISTRIBUTION PIPING
A. New steam distribution piping systems which connect to existing hot steam lines shall be tested as follows.
B. The new system shall be installed and the ends of the lines blanked off prior to making the connection to the existing hot line.
C. The new line shall then be heated by admitting high pressure steam (or low pressure if high pressure is not available) and the line brought up to pressure.
D. The line shall then be cooled to approximately ambient temperature.
E. The line shall then be hydrostatically tested as specified and thoroughly flushed out.
F. Make final connections to existing hot lines, energize and waste condensate.
G. De-energize and open and clean all dirt legs and strainers.

3.4 SCHEDULES
A. Hanger Spacing for Steel Steam Piping.
1. 1/2 inch (15 mm): Maximum span, 8 feet (2400 mm); minimum rod size, 1/4 inch (6 mm).
2. 3/4 inch (20 mm) and 1 inch (25 mm): Maximum span, 9 feet (2700 mm); minimum rod size, 1/4 inch (6 mm).
3. 1-1/4 inches (32 mm): Maximum span, 11 feet (3.3 m); minimum rod size, 3/8 inch (9 mm).
4. 1-1/2 inches (40 mm): Maximum span, 12 feet (3.6 m); minimum rod size, 3/8 inch (9 mm).
5. 2 inches (50 mm): Maximum span, 13 feet (4.0 m); minimum rod size, 3/8 inch (9 mm).
6. 2-1/2 inches (65 mm): Maximum span, 14 feet (4.2 m); minimum rod size, 3/8 inch (9 mm).
7. 3 inches (80 mm): Maximum span, 15 feet (4.5 m); minimum rod size, 3/8 inch (9 mm).
8. 4 inches (100 mm): Maximum span, 17 feet (5.1 m); minimum rod size, 1/2 inch (13 mm).
9. 6 inches (150 mm): Maximum span, 21 feet (6.4 m); minimum rod size, 1/2 inch (13 mm).
10. 8 inches (200 mm): Maximum span, 24 feet (7.3 m); minimum rod size, 5/8 inch (16 mm).

B. Hanger Spacing for Steel Steam Condensate Piping.
1. 1/2 inch (15 mm), 3/4 inch (20 mm), and 1 inch (25 mm): Maximum span, 7 feet (2100 mm); minimum rod size, 1/4 inch (6 mm).
2. 1-1/4 inches (32 mm): Maximum span, 8 feet (2400 mm); minimum rod size, 3/8 inch (9 mm).
3. 1-1/2 inches (40 mm): Maximum span, 9 feet (2700 mm); minimum rod size, 3/8 inch (9 mm).
4. 2 inches (50 mm): Maximum span, 10 feet (3.0 m); minimum rod size, 3/8 inch (9 mm).
5. 2-1/2 inches (65 mm): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (9 mm).
6. 3 inches (80 mm): Maximum span, 12 feet (3.6 m); minimum rod size, 3/8 inch (9 mm).
7. 4 inches (100 mm): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2 inch (13 mm).
8. 6 inches (150 mm): Maximum span, 17 feet (5.1 m); minimum rod size, 1/2 inch (13 mm).
9. 8 inches (200 mm): Maximum span, 19 feet (5.8 m); minimum rod size, 5/8 inch (16 mm).
10. 10 inches (250 mm): Maximum span, 20 feet (6.1 m); minimum rod size, 3/4 inch (19 mm).

END OF SECTION 33 63 00
SECTION 33 71 19 - ELECTRICAL UNDERGROUND DUCTS AND MANHOLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for underground electrical work, materials and products and raceway systems.

B. Related Sections:
   1. Section 31 23 33.13: Trenching and Backfilling for Site Utilities.
   2. Section 03 30 53: Miscellaneous Cast-in-Place Concrete.
   3. Dampproofing: Applicable Division 7 specification.
   5. Section 26 05 00 – Common Work Results for Electrical.
   6. Section 26 05 26 – Grounding and Bonding for Electrical Systems.
   7. Section 26 05 63 – Acceptance Testing of Electrical Systems.
   8. Section 26 05 13 - Medium Voltage Cables.
   10. Section 26 05 33.13 – Conduits and Backboxes for Electrical Systems.

1.2 REFERENCE STANDARDS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto:

B. American Society for Testing and Materials (ASTM):
   1. ASTM A 36, Specification for Structural Steel.

C. Federal Specifications (Fed. Spec.):
   2. Fed. Spec. FF-S-325, Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry) Group II (Shield, Expansion Bolt Anchor) Type 4 (Wedge expansion anchors) Class 1 (one piece steel expander with cone taper integral with stud).

1.3 QUALITY CONTROL

A. Equipment Manufacturer:
   1. In cases where the Contractor contemplates using equipment not made by the first named manufacturer of these specifications, refer to Section 26 05 00 of these specifications for special requirements and/or substitution requirements.

1.4 GENERAL REQUIREMENTS

A. Section 26 05 00, Common Work Results for Electrical, with the following additions and modifications.

B. Factory Tests:
   1. Determine applicable soil-density relationships for underground electrical installation bedding per applicable soil tests as defined in Division 2 of the Specifications.
2. Determine soil-density relationships for compaction of backfill material as defined in Division 2 of the Specifications.

1.5 SUBMITTALS

A. Submit the following information for approval:
   1. Catalog Information:
      a. Conduit. (All Types)
      b. Corrosion-Resistant Handholes.
      c. Precast Handholes.
      d. Manhole Frame and Cover.
      e. Handhole Frame and Cover.
      f. Sump Pumps.

1.6 CERTIFICATES

A. Material and Equipment: Provide manufacturer's statement certifying that the product supplied meets or exceeds contract requirements.
   1. Precast handhole and accessories.
   2. Manhole frame and cover.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Basic Electrical Materials: Those products such as building wire, connectors, fittings and similar devices as required for work of this Section are as specified in other Sections of these Specifications.

B. Provide materials and equipment listed by UL, when such equipment is listed or approved.

C. Conduit and Conduit Spacers: Conform to Section 26 05 33 13.

D. Wire and Cable: Conform to Section 26 05 13 and 26 05 19.

E. Grounding Material: Conform to Section 26 05 26.

2.2 WATERPROOFING OF CONDUIT JOINTS

A. General: Ensure that equipment and materials for waterproofing conduit joints complies with the following manufacturers for quality, installation procedures, and guaranteed end results.
   1. Rigid Metal Conduit:
      a. Thread sealant: As recommended and approved by the conduit manufacturer.
      b. Cleaning solvent: As recommended and approved by the conduit manufacturer.
   2. Non-Metallic Conduit:
      a. All weather, quick-set joint cement: Approved by the conduit manufacturer.
      b. Cleaning solvent: As recommended and approved by the conduit manufacturer.

2.3 CAST JUNCTION BOXES

A. Provide weatherproof and watertight junction boxes for flush in-ground installation where indicated on the Contract Drawings.
1. Construction: Cast iron type with necessary boxes, checkered cover, and neoprene gasket for flush mounting.
2. Install junction box in concrete pad as detailed on the Contract Drawings.
3. Provide box of minimum size of 8 inches x 8 inches; larger as required by the
4. National Electrical Code, or as indicated on the Contract Drawings and/or required by the
5. Acceptable Manufacturers:
   a. Appleton.
   b. Crouse Hinds.
   c. Killark.

2.4 PRECAST CONCRETE MANHOLES AND HANDHOLES

A. Provide precast concrete, watertight manholes/handholes as indicated on the Contract Drawings. Provide manholes/handholes complete with necessary, required and specified appurtenances such as watertight locking type covers, cable racks, pulling-in irons, ground rods and ladder and water drainage provisions.

B. Conform waterproofing work of manholes to requirements specified in appropriate Division 7 specification section.

C. Acceptable manholes/handholes manufactures as indicated on Contract Drawings or as approved equal.

2.5 SUPPORTS AND FASTENERS

A. Supporting Devices: Carbon steel angles, channels, and bars meeting material requirements of ASTM A 36. Pre-engineered UL Listed supporting systems of electrogalvanized steel or electrogalvanized steel PVC coated products may be used in lieu of field fabricated support systems.

B. Fasteners: Provide anchoring devices to anchor conduit or raceway, and supporting devices or pre-engineered supporting systems, to the structure, of the type designed for the specific purpose of anchoring into structure materials at intended point of installation. RAWL PLUGS NOT PERMITTED.
   3. Conform anchoring devices for fastening into solid masonry or concrete to Fed Spec. FF-S-325 Group II, Type 4, Class 1 for expansion type anchors.

2.6 UNDERGROUND WARNING TAPE

A. Printed polyethylene material, 4 mils minimum thickness with minimum one-inch high lettering. Overcoated graphics to read, "CAUTION-BURIED ELECTRIC LINE" for electric lines and/or "CAUTION - BURIED TELEPHONE" for telephone lines. APWA color to be red.

B. Acceptable Manufacturers:
   1. Brady #11296
   2. Seton.

2.7 GROUNDING

A. Ground rods are to be copper clad steel with diameter adequate to permit driving full length of the rod minus 6 inches, which extends above the finished concrete slab. Conform to Section 26 05 26 of these Specifications.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Incoming Service Requirements:
   1. Coordinate work and work requirements with Servicing Utility Company and the Owner prior to installation.
   2. Contact the following representative of the Serving Utility Company for electrical service installation requirements and to verify exactly the work required by the utility company to perform under this Contract.
      a. _______________ with PPL, Met-Ed, Allegheny Power, etc.
         Phone: _______________

B. General Requirements: (For Underground Work)
   1. Install underground conduit systems in accordance with Article 300-5 of the NEC, in accordance with previous requirements of this Section, and the following requirements exceeding NEC:
      a. Perform earthwork for buried conduit as specified previously for electrical work under Section 31 23 33.13: Trenching and Backfilling for Site Utilities.
      b. Install Concrete Encasement as indicated and detailed. Concrete as previously specified in Section 03 30 53: Miscellaneous Cast-in-Place Concrete.
      c. Where detailed on the Contract Drawings, underground conduits, both single and banked, concrete encase and reinforce using 5/8-inch steel reinforcing rods as indicated on the Contract Drawings.
      d. Bank conduits to the extent indicated and secure same in place with install separators at 5-foot intervals. Provide separators with sufficient strength to prevent displacement of conduits when placing backfill or pouring concrete encasement.
      e. Lay conduit lines to grade a minimum of three inches per 100 feet. Grade conduit lines away from buildings, except conduit lines running between buildings, without intervening handholes or manholes shall be level.
      f. Where conduit lines run to manholes, handholes or similar underground structures, grade conduits to drain to such.
      g. Construct underground conduit lines to be watertight. Stagger conduit couplings in banks of conduits.
      h. Unless otherwise indicated on drawing or details, where conduits change direction or turn up at equipment, transformers, buildings, terminal poles, etc., use long sweep PVC coated rigid galvanized steel conduit elbows.
      i. Provide two and one half feet minimum cover over conduits and over concrete encasement of conduit, unless indicated otherwise or specified.
      j. Where conduits are to be turned up into equipment or transformer pads, extend the concrete encasement for the conduits up to the top of the concrete pad and provide a 3/4" chamfer around exposed top edges. Isolate the concrete encasement for the conduits from the concrete pad for the equipment or transformer pad. Provide 2" high crushable fiber materials around duct bank encasement.
      k. Extend conduits 6 inches above concrete slab surface. Install insulating grounding bushing on all conduits. Perform concrete work as specified in Section 03 30 53: Miscellaneous Cast-In-Place Concrete.
      l. Where conduits are to be turned up at terminal poles, extend the concrete encasement for the conduits up pole to a height of 24 inches above finished grade and be provided with a 3/4" chamfer around all exposed top edges. Perform
concrete work as specified in Section 03 30 53: Miscellaneous Cast-In-Place Concrete.

C. Underground Duct Bank with Concrete Encasement: Construct underground duct bank lines of individual conduits encased in concrete as indicated. Except where rigid galvanized steel conduit is indicated or specified, use only one kind of conduit in any one duct bank. Use ducts no smaller than 4 inches in diameter unless otherwise indicated. Provide concrete encasement rectangular in cross-section surrounding the bank and provide at least 3 inches of concrete cover for ducts. Separate conduit by a minimum concrete thickness of 2-inches, and maintain a separation, between conduit centerlines, of seven and one-half inches. Separate power conduits from telephone, communication, and/or data highway conduits a minimum of 24 inches of earth or concrete thickness of 8 inches, unless otherwise indicated.

D. Place duct bank lines with a continuous slope downward toward manholes, handholes and away from buildings with a pitch of not less than 3 inches in 100 feet. Except at conduit risers, change direction of bends in runs exceeding a total of 10 degrees, either vertical or horizontal, by long sweep bends having a minimum radius of curvature of 25 feet. Sweep bends may be made up of one or more curved or straight sections or combinations thereof. Use only manufactured bends with a minimum radius of 18 inches for use with conduits of less than 3 inches in diameter and a minimum radius of 36 inches for conduits of 3 inches in diameter and larger. Terminate conduits in end-bells where duct bank lines enter manholes and handholes as indicated on the Contract Drawings.

E. Provide separators compatible with the conduit utilized and conforming to those specified in other Sections of these Specifications. Stagger the joints of the conduits by rows and layers so as to provide a duct bank line having the maximum strength. During construction, protect partially completed duct bank lines from the entrance of debris such as mud, sand, and dirt by means of suitable conduit plugs. As each section of a duct bank line is completed from manhole to manhole, from manhole to building or structure and/or from handhole to handhole, draw a testing mandrel not less than 12 inches long with a diameter 1/4 inch less than the size of the conduit, after which draw a brush having the diameter of the duct bank and stiff bristles through until the conduit is clear of particles of earth, sand, and/or gravel; immediately install conduit plugs. Provide a plastic pull rope, having a minimum of 3 additional feet at each end, in telephone and spare duct banks.

F. Underground Conduit for Service Feeders: Indicate underground conduit for service feeders into buildings on the Contract Drawings. Where rigid steel conduit bank is utilized, protect the ends of the conduit by threaded metal caps or brushings; coat the threads with graphite grease or other suitable coating. Clean and plug conduit before conductors are installed.

G. Conform concrete to that specified in Division 3 of this Specification.

H. Backfilling: Provide a continuous plastic warning tape about 12 inches below the top of the trench directly over each underground duct bank. Conform concrete to that specified in Division 3 of this Contract. Progress backfilling as rapidly as the construction, testing, and acceptance of the work permits. Ensure backfill is free from roots, wood, scrap material, and other vegetable matter and refuse. Install and compact backfill as specified in Section 31 23 33.13: Trenching and Backfilling for Site Utilities.

### 3.2 CONDUIT WATERPROOFING

A. Non-Metallic Conduit:

1. Plastic PVC Conduit (Schedule 40): Liberally coat the end of the conduit with an approved all weather, quick-set clear cement before joining. Insert joint into the coupling, pushing firmly, and rotating conduit until it reaches the pre-formed stopping ridge within the coupling.
3.3 MANHOLES/HANDHOLES

A. Provide steel bar pulling-in irons bent in the configuration of a deformed "Z" and cast in the walls and floors. Pocket pulling-in irons in the floor and center directly under the manhole cover. Locate pulling-in irons in the wall not less than 6 inches above or below, and opposite the conduits entering the manhole. Locate the pulling-in-irons such as not to interfere with the cable distribution racks. Project pulling-in-irons into the manhole approximately 4 inches. Zinc-coat irons after fabrication.

B. Ensure cable racks, including hooks and insulators, are sufficient to accommodate the cables and spaced not more than 24 inches horizontally. Provide wall bracket of glass reinforced nylon channel. Provide support brackets of glass reinforced nylon and of the removable type. Provide insulators of dry-process glazed porcelain.

C. Hot-dipped galvanize all metal-work within the manhole, including the steel ships ladder after fabrication and ground.

3.4 MANHOLE/HANDHOLE INSTALLATIONS

A. Where openings into manholes are below final finished grade, extend openings to the required elevation with either concrete or brick suitably arranged to support or anchor the frames and covers. Obtain engineer approval of the construction method and procedure before any work is done.

B. Where required for pulling cables, furnish and install in the walls of the manholes and handholes, a sufficient number of inserts for the proper attachment of cable supports.

C. In general, properly dress and rack cable/or wire on the support arms and insulators around the walls of the manholes and handholes, providing slack where required for future rearrangements. Install cable support brackets, along with the support arms and porcelain insulators, on each wall of the manhole and handhole. Secure cables within manholes and handholes to the insulators by marlin rope. Use proper regard for neat and orderly appearance and location, and provide accessibility for future connections. Take care not to damage the walls of the manholes and handholes during cable pulling.

D. Provide each manhole with a 1 inch diameter hole in the floor for a ground rod. Provide a 3/4 inch diameter by 10 foot long copper clad ground rod installed in one corner with 6 inches of the ground rod left extended above finished floor. Seal through floor using materials specified in the applicable Division 7 specification section. Ground metal work to the ground rod.

E. Conform manhole frames and covers to requirements as outlined above in these Specifications; and ensure Engineer approval.

F. Provide a manhole drainage system as indicated on the Contract Drawings.

3.5 FRAME AND COVER INSTALLATION

A. Where required, make final adjustment of frame to elevation using materials grade rings.
   1. Set precast grade rings in Waterproof Mortar. Do not exceed 3/4-inch maximum and 3/8-inch minimum mortar thickness. Wet, but do not saturate precast grade rings immediately before laying.
   2. Precast grade ring: Pre-set to proper plane and elevation using wedges or blocks of cementation material not exceeding one spare inch wide on each side. Permit no more than four wedges or blocks per grade ring. Incorporate wedges or blocks in fresh mortar in a manner to completely encase each. Crown fresh mortar to produce squeeze-out
between grade rings. Tool exposed joints with appropriately shaped tool and compact mortar edge into joints. Clean off excess mortar prior to initial mortar set.

3. Bolt manhole frames in place on manhole top section, or on leveling units if required, after installing 2 inch thick preformed plastic sealing compound on bearing surface of manhole frame. Remove excess sealing compound squeeze-out after manhole frame is bolted in place.

4. Use bolts of sufficient length to properly pass through leveling units, if used, engage full depth of manhole top section inserts and allow enough threaded end to pass through manhole frame to properly tighten nut and washer. Tighten manhole frame bolts after mortar has cured.

3.6 FIELD COATING

A. Clean cast-iron or steel frames, covers and gratings not buried in masonry of mortar, rust, grease, dirt, and other deleterious materials by an approved blasting process, and give a coat of bituminous coating material. Clean surfaces that cannot be cleaned satisfactorily by blasting to bare metal, by wire brushing, or other mechanical means. Wash surfaces contaminated with rust, dirt, oil, grease or other contaminants with solvents until thoroughly cleaned. Immediately after cleaning, coat surface with a pretreatment coating or give a crystalline phosphate coating. As soon as practicable after the pretreatment coating has dried, prime treated surfaces with a coat of zinc chromate primer and coat with synthetic exterior gloss enamel.

3.7 WATERPROOFING MANHOLES

A. Apply a specified protective coal-tar-based coating of two applied coats, minimum, to surfaces in direct contact with in ground cover to obtain a minimum 12.0 dry mil total applied surface thickness. Apply coating in strict conformance with manufacturer's requirements. Topcoat coating with a sunlight protective inhibitor. Provide coating with a vapor resistance of at least 0.5 perms.

B. Have the manufacturer certify and, on request, submit test reports by a laboratory acceptable to the Engineer proving that the material proposed meets the requirements and has been in successful commercial use on structures of a similar type for a period of at least five years.

C. Note:
   1. A perm is a standard unit of permanence relating to rate of water vapor transmission through a specimen coating.
      weight of water (grams)
      Perms =length of test (hours x area of specimen (sq. ft.) x vapor pressure difference from one side of specimen to the other (inches in mercury)

3.8 CONNECTIONS TO MANHOLES/HANDHOLES

A. Construct concrete encased duct bank lines connecting to manholes or handholes to have a tapered section adjacent to the manhole or handhole to provide shear strength. Construct manholes and handholes to provide for keying the concrete envelope of the duct bank line into the wall of the manhole or handhole. Use vibrators when this portion of the envelope is poured to assure a seal between the envelope and the wall of the manhole or handhole.

3.9 CABLE DUCT BANK SHIELDS

A. Provide shields of a suitable type manufactured for the purpose where cables enter and leave manholes and handholes and other duct bank entrances.
3.10  EARTHWORK

A. Excavate to depths as required for manholes and handholes. Excavation for manholes and handholes shall conform to the requirements stipulated in Division 2 - Site Work.

B. Remove waste excavated materials not required or suitable for backfill on the project from the site as directed. Provide sheeting and shoring as necessary for projection of work and safety of personnel. Remove water from excavation by pumping or other approved method.

3.11  GROUNDING

A. Provide non-current carrying metallic parts associated with electrical equipment with a maximum resistance to solid “earth” ground not exceeding the values indicated in Section 26 05 63 of these Specifications.

3.12  DISSIMILAR SURFACES ISOLATION

A. Paint aluminum surfaces at point of contact with wood, concrete or masonry construction with one coat (minimum dry mil thickness - 5.0 mils) of bituminous paint.

B. Clean away excess or misplaced paint materials from aluminum surfaces and adjoining construction materials.

3.13  TEST

A. Field Tests: Field test of electrical equipment and conform systems to those specified in Section 26 05 53 of these Specifications.

END OF SECTION 33 71 19