**Design Project 2**

For the GE project we had to design a locomotive to meet the EPA's new emission requirements by reducing particulate matter to at least 0.1 (g/hp-hr) and reducing oxides of nitrogen to at least 5.5 (g/hp-hr), while looking for a cost effective solution which reduces smog, maintains a good public opinion, and does not compromise delivery time or freight capacity.

We then developed three possible options, that went into detail

Option 1 - Sell current locomotives that no longer meet EPA standards and buy new locomotives that meet tier 4 standards

Cost

\[
\text{Cost}(\text{New Locomotive}) + \text{Cost(Operations/year)} - \text{Income(Current Locomotive)}
\]

\[
4,000,000 \text{ (cost of new locomotives)} - 1,000,000 \text{ (Estimated income from current locomotives)} = 3,000,000
\]

Emission

\[
\text{Emission}(\text{New Locomotive Operations/year})
\]

0.03 PM and 1.3 NO

Numbers from Freight, Fuel, & Emissions EDSGN100 powerpoint

Option 2 - Update current fleet and locomotives to tier 3

Cost

\[
\text{Cost(Updating Current Locomotive)} + \text{Cost(After-treatment)} + \text{Cost(Operations/year)}
\]

\[
750,000 \text{ (updating cost)} + 100,000 \text{ (after treatment cost)} = 850,000
\]

Emission

\[
\text{Emission}(\text{Updated Locomotive Operations/year})
\]

0.1PM and 5.5 NO

Numbers from Freight, Fuel, & Emissions EDSGN100

Option 3 - Utilize alternative fuels to get emissions to tier 4

Cost

\[
(\text{Locomotive Upgrade}) + \text{Cost(Fueling Station)} + \text{Cost(Operations/year)}
\]

\[
1,000,000 \text{ (upgrade cost)} + 1,000,000,000 \text{ (fueling station cost)} = 1,001,000,000
\]

Emission

\[
\text{Emission}(\text{Upgraded Locomotive/year})
\]

0.03 PM and 1.3 NO (estimated)

We then broke it down to what ultimately mattered: the price and emissions.

<table>
<thead>
<tr>
<th>Option</th>
<th>Emission</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Buy new locomotives</td>
<td>1.3 NO</td>
<td>$3,000,000</td>
</tr>
<tr>
<td>2. Upgrade locomotives</td>
<td>5.5 NO</td>
<td>$850,000</td>
</tr>
<tr>
<td>3. Utilize alternative fuels</td>
<td>1.3 NO</td>
<td>$1,001,000,000</td>
</tr>
</tbody>
</table>

After going through these and a few extra steps we decided to ultimately go with tier 4 locomotives due to the drastically reduced emissions at a relatively affordable cost.