The task of Design Project II was to use the given information from General Electric (GE) to choose the best solution to decide which method of shipment and which locomotive should be used that is most efficient. The requirements that were to be met for GE are shown below.

Requirements from GE:

- Transport Approx 165,000-tons of freight
- Get Locomotives to meet EPA standards (have to be at least tier 3)
- Reduce smog
- Cost effective solution

Our team decided that it was best to sell all of the tier 2 locomotives, and then purchase and upgrade all of the tier 3 locomotives; this option was better in comparison to using the newest tier 4 locomotive. Afterwards, we developed a detailed process draft, explaining the steps of the process and how we arrived at our conclusion.

Detail Process Draft

Step 1: Original Situation

We have 50 locomotives tier 2 and they all have to transport 165000 tons of freight. The locomotives have to be upgraded to at least tier 3 to meet EPA standards and that would cost 750k each to upgrade to tier 3. The main goal is to reduce the smog in the city.

Step 2: identify potential problems

Budget: Although there are many options that are extremely environmentally friendly, the locomotives are too expensive. For example, Tier 4 will be our idea locomotive as it is highly fuel efficient and environmentally safe, but it costs too much.
Reduce NOx pollution and Reduce PM: The current situation with tier 2 locomotives, the train is emitting too much NOx pollution that is lethal to the environment. We need to find a solution that is less harmful for the health of others.
Fuel Efficient: The amount of fuel is coming to a short end in our society. As this is occurring we need to fix our locomotives to be fuel efficient so that we make the most of the little fuel that is available.

Step 3: List possible improvements

Alternative Fuels: Utilize alternative fuels: too expensive as the refueling station alone costs around 1 billion dollars. Even though alternative forms of energy such as electricity are much more efficient, the cost of buying new locomotives that would be able to implement these fuels is too great.

Alternate methods of transportation (i.e. not a locomotive):
Trucks: Using trucks as our transportation method will be too harmful for the environment. It emits too much pollution and it will not be fuel efficient.

Boats: We already have the infrastructure for the locomotives and boats would force us to create a new system for refueling and maintaining them, they also are very slow and the city needs the freight in a timely manner.
Planes: Choosing air transportation will be too costly. The cost for choosing planes will be twice if not three times as much as choosing trains.

Tier 4 Locomotive: Tier 4 locomotives are the most efficient and effective option when it comes to limiting the amount of NOx and PM emissions released by the train. However, like all things that are eco-friendly, the cost is much greater than the other tiers. In comparison to tier 3, the cost of being environmentally conservative is not worth the price

Tier 3 Locomotive:The regular tier 3 locomotives did not have any substantial decrease in NOx which was our most important quality when we mapped out what we wanted with AHP and the Borda Count

Tier 3 Locomotive with after treatment (genset switcher): The genset switcher is a different engine that knows when to turn on certain parts to maximise efficiency. Environmental benefits of GenSets include:
- Fuel savings of more than 20%, compared to existing diesel locomotive technology in side-by-side use, have been demonstrated.
- Compared to a traditional locomotive in the same application, GenSet units have been shown to reduce NOx by 58%, HC by 94%, CO by 37% and PM by 80%.

Step 4: finding optimal solution (process)
Borda Count

(A) Cost: 2

(B) Fuel Savings:1

(C) Reduction of NOx: 4

(D) Reduction of PM: 3

Self Comparisons:

A>B A<C A<D A=A
B<C B<D B=B
C>D C=C
D=D

Ranking: **C** Reduction of NOx, **D** Reduction of PM, **A** Cost, **B** Fuel

C Weight Of Reduction of NOx: 0.4
D Weight of reduction of PM: 0.3

A Weight of reduction of Cost: 0.2
B Weight of reduction of Fuel Savings: 0.1

AHP

	Reduction of NOx	Reduction of PM	Fuel Savings	Cost	Total	Weight
Reduction of NOx	1	2	4	2	9	.4408
Reduction of PM	1/2	1	2	3/2	5	.2449
Fuel Savings	1/4	1/2	1	1/2	2.25	.1102
Cost	1/2	2/3	2	1	4.16	.2037
Total	2.25	4.16666	9	5	20.416666	~1

Step 5 Detail solution
Tier 3 locomotives with after treatment:

The genset switcher is a different engine that knows when to turn on certain parts to maximize efficiency. The genset switcher is a tier 3 locomotive that includes the after treatment. The genset switcher locomotive saves more than 20% of fuel, compared to the existing diesel locomotive technology in side-by-side use. Also, the GenSet units will save 58% of NOx, 94% of HC, 37% by CO, and 80% of PM. By looking at the statistics of the GenSet locomotives, we decided to sell all the tier 2 locomotives for 750,000 dollars and the locomotives had to be upgraded regardless to meet EPA standards to tier 3 and that would cost 750,000 dollars each so we have a budgets of 75 million to work with which enables us to buy 53 GenSet Switcher locomotives.