

GE Transportation

Freight, Fuel, & Emissions

Introduction to Engineering Design EDGSN 100 Section 002

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Introduction

Tier 2 locomotives used to haul freight are approaching age for overhaul, at which time investments will be required to meet EPA Tier 3 requirements. Suggestions have been made to address locomotive emissions (i.e. smog) by upgrading the locomotive fleet to meet more recent emissions guidelines set by the EPA, sell existing fleet and purchase new locomotives or seek other transportation methods.







Transportation Infrastructure Condition and Capacity

- Roads and bridges are in a state of disrepair
- Waterways are in acceptable condition
- Within Pennsylvania, railways have the best condition by far.



Standard Capacity for Alternate Transportation Modes

- Number of each to maintain current freight transport
 - 8 15-Barge Tows
 - We will be using barges with a storage capacity of 20,000 tons
 - Therefore, 9 barges are needed
 - 16 100-car trains
 - 6346 large semi-trucks




Mode of Transportation	Tons of Cargo	Bushels of Cargo	Gallons of Cargo
 One Barge	1,500 tons	52,500 bushels	453,600 gallons
 One Rail Car	100 tons	3,500 bushels	30,240 gallons
 100-car Train Unit	10,000 tons	350,000 bushels	3,024,000 gallons
 Large Semi	26 tons	910 bushels	7,865 gallons

Transportation Costs and Concept of Operations (ConOps)

- Barges = \$0.0091 per ton mile → \$1,501.50 per mile for 165,000 tons
- Trains = \$0.0403 per ton mile → \$6,649.50 per mile for 165,000 tons
- Trucks = \$1.29 per ton mile → \$212,850 per mile for 165,000 tons
- Nine 20,000 ton barges needed to transport approximately 165,000 tons.
- Use the Great Lakes lock and dam system as well as other inland waterways

Energy Efficiency of Shipping Methods

Number of miles one ton can be carried per gallon of fuel
(Adapted from U.S. DOT Maritime Administration)

Mode of Transportation	Number of Miles/Gallon Carrying One Ton of Cargo
	514 miles/gallon
	202 miles/gallon
	59 miles/gallon

EPA Diesel Emission Standards

Standards for Line-Haul:	Effects by year:	PM	NOx	HC
Remanufactured Tier 0 and 1	2008 as available, 2010 required	0.22	7.4	0.55
Remanufactured Tier 2	2008 as available, 2013 required	0.1	5.5	0.3
New Tier 3	2012	0.1	5.5	0.3
New Tier 4	2015	0.03	1.3	0.14

Standards for Switch:	Effects by year:	PM	NOx	HC
Remanufactured Tier 0	2008 as available, 2010 required	0.26	11.8	2.1
Remanufactured Tier 1	2008 as available, 2010 required	0.26	11	1.2
Remanufactured Tier 2	2008 as available, 2013 required	0.13	8.1	0.6
New Tier 3	2011	0.1	5	0.6
New Tier 4	2015	0.03	1.3	0.14

Diesel Engine Exhaust Emissions (DEEE)

The emissions resulting from using diesel as a fuel source are:

NOx = $N_2 + O_2 \rightarrow (NO, NO_2)$ depending on the amount of heat delivered.

- Higher temperature \rightarrow Higher NOx

PM = Particular Matter is not a single substance, it is a process of anything collected on test filter. It focuses on oil control, wear management, and compression.

CO₂ & Hydrocarbons: $C_xH_y + O_2 \rightarrow CO_2 + H_2O$

- $C_{in} = C_{out}$, Fuel consumption and CO₂ production are directly proportional.
- CO₂ and Hydrocarbons are related because they happen in the same reaction.

Locomotive Fleet Upgrade

The locomotives used in Pittsburgh to transport 165,000 tons of freight use diesel as the fuel source. Running diesel fuel causes the production of big amounts of nitrogen oxide (NO_x), which leads to the appearance of smog and as a result, there has been complains from the city residents. There's been a list of solutions proposed to this problem:

1. The usage of alternative fuels
2. Alternative methods of shipping
3. Sell existing fleet and purchase new ones
4. Upgrade fleet with exhaust after-treatment hardware

The strategy that was ultimately selected was the upgrading of Tier 2 to Tier 3 locomotives due to the improvements in the areas of availability (less interruption hours) and infrastructure it would provide, and due to the relative low cost of the operation.

Summary

In response to the issue of aging trains for the shipment of goods in and out of Pittsburgh, this group chose to have the trains replaced by barges because doing so will cost less and be more effective than upgrading the trains or replacing them with trucks, as well as being a safer option. In addition, many of the roads and bridges in Pennsylvania were inspected and were found to be structurally deficient and are in need of maintenance (both of them scored a D- in quality). The Pennsylvania Inland Water Ways scored a D+, and the railway systems scored a B which cements its place as the most reliable form of transportation of the three. As for the smog problem and the introduction of new EPA guidelines, we chose upgrading from Tier 2 to Tier 3 locomotives as the solution as it would mean better infrastructure, more availability, and less cost than say using alternative fuels.

Closing

This group has been tasked with coming up with the best possible solution for the issue of aging trains for the shipment of goods in and out of Pittsburgh. The issue is brought about by the aging fleet of diesel powered trains that currently bring goods in and out of the city. These trains needed to be upgraded or replaced by either newer trains or other forms of transportation. These other forms of transportation include both trucks and barges. This group chose the latter for the solution to this problem. The outright cost is much less than that of both upgrading the trains or using trucks, with an added bonus of being a safer, less volatile form of getting goods from one place to another. Barges are the best option for the aging train problem in Pittsburgh.