

GE Transportation

Freight, Fuel, & Emissions

Introduction to Engineering Design EDGSN 100 Section 002

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INTRODUCTION

Design Project sponsored by General Electric (GE) Transportation.

Objective: design a cost effective solution that reduced the amount of smog emitted by trucks, barges and locomotives traveling to Pittsburgh

Additional Criteria:

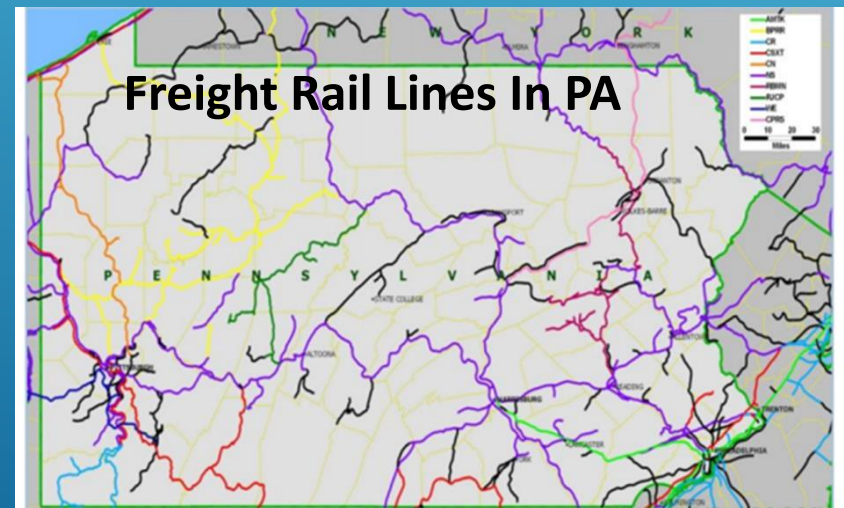
- ▶ solution had meet EPA requirements and had to maintain an increasing freight capacity coming into and out of this important port city
- ▶ the mineral (coal) trip had to be close to 500 miles round-trip and the commodities transport total distance was 1,000 miles round-trip

Some suggestions that have been made to reduce the amount of smog emitted include:

1. Upgrade the locomotive fleet to meet recent emission guidelines set by the EPA (sell existing fleet, upgrade fleet, and utilize alternate fuels)
2. Alternate freight shipping methods (sea, air, ground)

TRANSPORTATION INFRASTRUCTURE CONDITION AND CAPACITY

- ▶ Bridges: D+, Roads: D-, these grades indicate both need much improvement, there are 22,600 bridges in Pennsylvania and 23% have been found to be deficient
- ▶ The capacity of bridges are down 21.8% from 2001, to increase use/capacity of roads there is a current need for more lanes
- ▶ Inland Waterways: D+, due to a lack of maintenance over the years
- ▶ These conditions cause a decrease in the use of the waterways, they are not used to full capacity
- ▶ Freight Rail System: B, Pennsylvania has 65 freight railroads that expand approximately 5,145 route miles
- ▶ The lines that are not frequently traveled are often called abandoned, which poses risks, about 124 rail lines are “abandoned” and 96 of these lack traffic



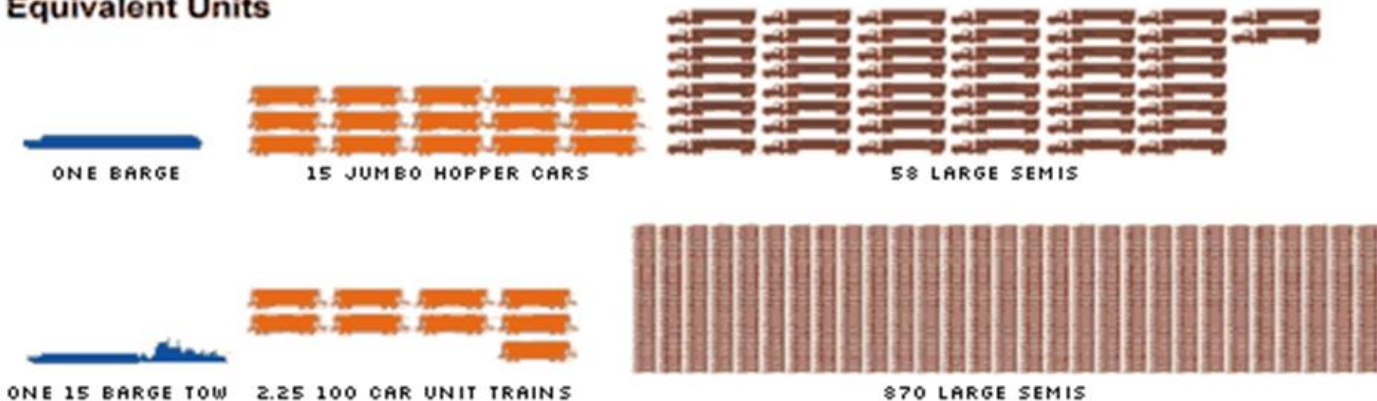
STANDARD CAPACITY FOR ALTERNATE TRANSPORTATION MODES

Compare...

Cargo Capacity

				
ONE BARGE	ONE 15 BARGE TOW	JUMBO HOPPER CAR	100 CAR TRAIN UNIT	LARGE SEMI
1,500 TON	22,500 TON	100 TON	10,500 TON	26 TON
52,500 BUSHELS	787,500 BUSHELS	3,500 BUSHELS	350,000 BUSHELS	910 BUSHELS
453,600 GALLONS	6,804,000 GALLONS	30,240 GALLONS	3,024,000 GALLONS	7,865 GALLONS

Equivalent Units



Equivalent Lengths



TRANSPORTATION COSTS



Most Economical Transportation Solution: After looking at the total costs to ship by using the various modes of transport, and after incorporating fuel costs, we concluded that shipping by fifteen barge tows are the most efficient. Using inland waterways, we can ship vast amounts of freight, for a lowered cost, while also becoming more environmentally friendly.

EPA DIESEL EMISSION STANDARDS

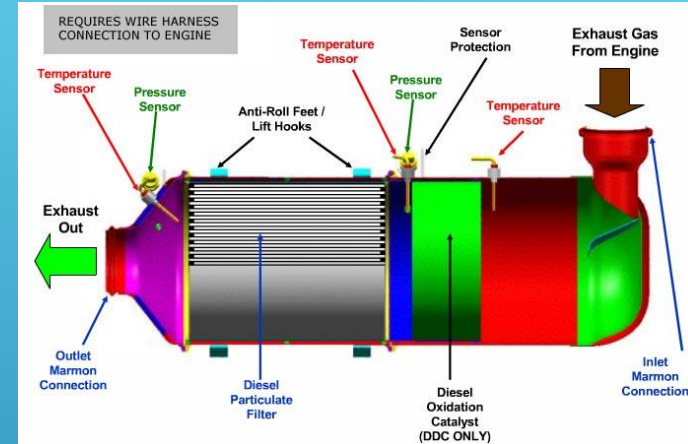
- ▶ The EPA gives diesel powered locomotives different Tiers and standards based on newly manufactured engines or remanufactured engines built in certain years.
- ▶ Tier III locomotives have near-term standards and Tier IV locomotives have long-term standards. Since Tier IV has long-term standards Tier IV locomotives have emission control devices such as particulate filters and NOx emissions control.

EPA Emission Standards				
	HC	CO	NOx	PM
Tier 0 (1973 – 2001)				
Line-Haul	1.0	5.0	9.5	0.60
Switch	2.1	8.0	14.0	0.72
Tier1 (2002 – 2004)				
Line-Haul	0.55	2.2	5.5	0.20
Switch	1.2	2.5	8.1	0.24
Tier 2 (2005 – 2011)				
Line-Haul	0.3	1.5	13.5	0.34
Switch	0.6	2.4	19.8	0.41

EPA Emission Standards Contd.				
	HC	CO	NOx	PM
Tier 3 (2012 – 2014)				
Line-Haul	0.30	1.5	5.5	0.10
Switch	0.60	2.4	5.0	0.10
Tier 4 (2015)				
Line-Haul	0.14	1.5	1.3	0.03
Switch	0.14	2.4	1.3	0.03

DIESEL ENGINE EXHAUST EMISSIONS (DEEE)

- ▶ NO_x is formed when air is heated
- ▶ PM is the sum of all solid and liquid particles suspended in air, PM contains smoke, pollen, dust, soot, etc.
- ▶ CO₂ is a gas that forms in direct proportion to any amount of fuel consumed
- ▶ HC when combined with O₂ combust and CO₂ gas forms
- ▶ Emissions of these chemicals can cause human health issues, the issues range from lung function damage, ease of breathing, excessive amounts of CO₂ in blood, irregular heartbeat, etc.
- ▶ Retrofitting, which involves the addition of an emission control device to the engine exhaust, this strategy can eliminate up to 90% of pollutants in certain cases
- ▶ Switch to alternative fuels like:
 - ▶ Emulsified Fuel: reduces both PM and NO_x emissions
 - ▶ Biodiesel: can reduce CO₂ by 10% and decrease PM by 15%



LOCOMOTIVE FLEET UPGRADE

Investment Data

Diesel Locomotive Upgrade		New Locomotive		Alternative Fuels	
Tier II → Tier III	\$750 K	Tier III Locomotive	\$3 M	Locomotive Upgrade	\$1 M
After Treatment	\$100 K	Tier IV Locomotive	\$4 M	Fueling Station	\$1 B

- ▶ Upgrade Strategy. The chosen use of barges negates the complete overhaul of the fleet as most of the fleet will be sold to be replaced with barges. The single 75-car locomotive that remains will be fully upgraded to Tier Three and will be treated with the after-treatment which gives an advance well worth the cost. This strategy will reach EPA requirements and even return a profit.
- ▶ Upgrade Schedule and Costs. As seen in table three, the cost of a new dry barge is \$200,000 whereas the selling price of a tier II locomotive is around \$1 mil. There are 105 barges in total being purchased and 49 trains being sold. Also, one train is being fully upgraded to Tier III and given the after-treatment for a total of \$850,000. Therefore, the benefits greatly out-price the costs giving a remarkable profit of \$27,250,000 using this upgrade strategy.




SUMMARY

- ▶ Barges have a large advantage over the other cargo transportation methods
- ▶ Barges are the best in terms of economic efficiency and environmental friendliness, they also can carry large amounts of materials at one time
- ▶ With the distance needed to travel given in the statement of work and the importance of protecting the environment from harmful emissions, barges fit the transportation needs better than the other two forms of transportation
- ▶ It is also important to various forms of shipping methods in case one fails; thus, it is best to upgrade at the least one train for any random emergency that possibly could occur



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ALLIEOOPS



Merry Christmas, you filthy animal...
and a happy New Year.