PennState College of Engineering

GE Transportation

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Freight, Fuel, & Emissions

Introduction to Engineering Design
EDGSN 100 Section 002

G4/ Group #4
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Introduction

- The project objective was to look for a cost effective solution which reduces smog, while maintaining or increasing freight capacity. This project is for the transportation of freight in Pittsburgh under EPA requirements.

- Approximately 165,000 tons of freight or minerals per day travel in or out of the city of Pittsburgh. Smog from locomotive emissions is a key component of city residents. Tier 2 locomotive that are used to haul freight are approaching the age for overhaul, at which time investment will be required to meet EPA Tier 3 requirements.

- The project sponsor was General Electric Transportation.

Transportation Infrastructure Condition and Capacity

- Pennsylvania is in need or major upgrades for all of their infrastructure. Almost every aspect of our infrastructure scored below a C, especially our roads, bridges and inland waterways.
- Roads are in bad conditions, but so are ¼ of all bridges in Pennsylvania. The grade of the roads was a D- and it hasn't changed since 2010.
- Not a single satisfactory rating for Navigation Dams. Capacity for inland waterways is bigger than what is used. The grade is only a D+. The M-70 goes from Pittsburgh to Kansas City and also connects with the Mississippi River.
- Railroads are the best way to travel long distances for large amounts of quantities. Short distance railroads are at risk of abandonment. The condition of the railroads isn't great and needs repair for bridges larger than $170,000,000.00. Choke point & heavy load infrastructures need repair.

Standard Capacity for Alternate Transportation Modes

- One barge weighs 1,500 tons, one 15-barge tow weighs 22,500 ton. One bulk type railroad car like a jumbo hopper car weighs 100 tons. One boxcar type railroad car like a 100-car train unit weighs 10,500 ton and a large semi weighs 26 ton, which has the lowest capacity comparing to the others. Moreover, among those transportation modes, the 15-barge tow has the highest cargo capacity.

- The cargo capacity of one barge is equivalent to 15 jumbo hopper cars or 58 large semis. Moreover, the cargo capacity of one 15-barge tow is equivalent to 2.25 100 car unit trains or 870 large semis.

- One 15-barge tow is about 0.25 miles long. The length of 2.25 100-car train unit is 2.75 miles and 870 large semis are about 11.5 miles long.

Transportation Costs and Concept of Operations (ConOps)

Trucks: At an average speed of about 50 miles per hour, you will find that the cost for traveling round trip is $2,165.28. The total cost calculated for round trip will take around 12 hours.

Railroad: The average cost for one jumbo hopper car to travel round trip is $32,800. The total time to go round trip is around 6 hours and 40 minutes if the train went 120 miles per hour.

Barges: The total amount of time it takes to travel just one way is 2 full days & 14.5 hours. The total cost to go round trip is equal to $736,193.

EPA Diesel Emission Standards

- **EPA proposed a three part program that will significantly reduce all types of diesel locomotives emissions in March 2008, which are line-haul, switch, and passenger rail. If fully implemented, it reduce the emission of PM by 90% and NOx by 80%. The standards are based on manufactured engines built in 2015 and later with high-efficiency catalytic after treatment technology. EPA standards can also be applied for existing locomotives to reduce idling for new and remanufactured locomotives.**

	Duty-Cycle[b]	Tier	Year[c]	HC[c] (g/hp-hr)	NOx (g/bhp-hr)	PM (g/bhp-hr)	CO (g/bhp-hr)	Smoke[m] (percentage)	Minimum Useful Life (hours / years / miles)[n]	Warranty Period (hours / years / miles)[n]
Federal[a]	Line-haul	Tier 0	1973-1992[d,e]	1.00	9.5 [ABT]	0.22 [ABT]	5.0	30 / 40 / 50	(7.5 x hp) / 10 / 750,000[o]	1/3 * Useful Life
		Tier 1	1993-2004[d,e]	0.55	7.4 [ABT]	0.22 [ABT]	2.2	25 / 40 / 50	(7.5 x hp) / 10 / 750,000[o]	
									(7.5 x hp) / 10 / -	
		Tier 2	2005-2011[d]	0.30	5.5 [ABT]	0.10[k] [ABT]	1.5	20 / 40 / 50	(7.5 x hp) / 10 / -	
		Tier 3	2012-2014[f]	0.30	5.5 [ABT]	0.10 [ABT]	1.5	20 / 40 / 50	(7.5 x hp) / 10 / -	
		Tier 4	2015+[g]	0.14	1.3 [ABT]	0.03 [ABT]	1.5	-	(7.5 x hp) / 10 / -	
	Switch	Tier 0	1973-2001	2.10	11.8 [ABT]	0.26 [ABT]	8.0	30 / 40 / 50	(7.5 x hp) / 10 / 750,000[o]	
		Tier 1	2002-2004[h]	1.20	11.0 [ABT]	0.26 [ABT]	2.5	25 / 40 / 50	(7.5 x hp) / 10 / -	
		Tier 2	2005-2010[h]	0.60	8.1 [ABT]	0.13[i] [ABT]	2.4	20 / 40 / 50	(7.5 x hp) / 10 / -	
		Tier 3	2011-2014	0.60	5.0 [ABT]	0.10 [ABT]	2.4	20 / 40 / 50	(7.5 x hp) / 10 / -	
		Tier 4	2015+	0.14[j]	1.3[j] [ABT]	0.03 [ABT]	2.4	-	(7.5 x hp) / 10 / -	

Diesel Engine Exhaust Emissions (DEEE)

- Nox, particular matter, CO2 and hydrocarbons cause major pollution problems around Pittsburgh.
- Regulations can be put in place similar to European countries that have established Euro standards which have continuously been lowered since 1993 with Euro I to Euro VI.
- Alternate fuels of diesel include biodiesel, methyl alcohol can reduce or eliminate the pollutant. They have been used to prevent the sulfur damage.

Locomotive Fleet Upgrade

- A large portion of the operating expense of a large-bore diesel engine is fuel cost and the flow restriction of the after-treatment system is one of the influences on fuel consumption. The additional work that the engine has to perform in order to exhaust the combustion products from the engine translates into additional fuel used.
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- Utilize alternative fuels (Biodiesel, CNG, LNG, etc.) which may produce less NOx. Basically, there are alternate fuels like Biodiesel (B100), Natural gas, Propane (liquefied petroleum gas), Electricity, Hydrogen and ethanol etc.

Summary

For the transportation under EPA requirement of Pittsburgh for the company GE Transportation, the goal of this project is to maintain and increase the freight capacity and while reduce the emissions. In the process of developing the shipping method, our design team set trains as our project since it is the most efficient one among all of the options, and we evaluated the costs and emissions of this shipping method. Our goal is to upgrade the locomotives to meet the requirements set by EPA from Tier 2 to Tier 3-4. Some upgrade strategies include selling existing fleet and purchasing new fleet, upgrading fleet with exhaust after-treatment hardware, and utilizing alternative fuels such as biodiesels, CNG and LNG. Comparing these three strategies, utilizing alternative fuels, especially liquified natural gas, is the best solution because of the low cost and sustainability. Therefore, our suggestion is replacing the traditional fuel by liquified natural gas.

Closing

After our evaluation of both proposals, we decided that the best decision would be to upgrade locomotives. Rail systems overall had the best rating and will be the easiest and cheapest to improve. While it will be expensive to upgrade the actual locomotives, it will be worth it in the long run because the rail system is currently not being used very much, it can be used in all types of weather, and in a busy city like Pittsburgh, shipping will be very efficient because there wont be any air, water, or road traffic to worry about.