Air Quality and Energy Issues

Trucks, Trains, Ships, and Planes: An Update on Goods Movement-Related Emissions

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Linking Good Movement to Economic Prosperity and Environmental Quality
UCLA Lake Arrowhead

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Freight Market Share by Mode

Market share per ton-mile

- Other and unknown modes
- Multimodal combinations (1)
- Pipeline
- Air (includes truck and air)
- Water
- Rail
- Truck

Freight Choice

• Value/speed of freight
  • Truck - $700/ton; at most 50-60 miles per hour
  • Rail - $200/ton; <40 mph; ~20 mph average
  • Water - $370/ton; <20 knots; ~10 knots average
  • Pipeline - $200/ton; limited to gases and liquids

• Other considerations
  – Range/haul length, type and size of freight, point to point distribution
Fuel Efficiency

• National system-wide average (net revenue freight)
  – Truck ~ 40 to 50 ton-mile/gallon
  – Rail ~ 400 ton-mile/gallon
  – Water ~ 350 ton-mile/gallon

• Best Case
  – Truck ~ 125 ton-mile/gallon (loaded multi-trailers)
  – Rail (unknown likely similar to water)
  – Water ~ 800 ton-mile/gallon (over some current routes)
Factors Affecting Efficiency

- Empties (less than full load) ~ 50 - 100% effect (improving the ton-mile per gallon)
- Duty cycle (idle, speed/congestion) ~ 5 – 50% effect
- Technology (aero/hydrodynamics – faring, train/truck size, ship design; engine/transmission efficiency) ~ up to 25% effect
- Maintenance/other (good working order, proper lubrication) ~ up to 10% effect
Emissions Rates

• Per engine emissions
  – Average in-use accounting for fleet turnover
  – Emission standards; current and future
    • Truck engine standards very strict especially after 2007
    • Locomotive and marine similar to each other

• Per ton-mile
  – Includes freight efficiency
Per Engine NOx Emissions Rates

- Average In-Use 2004
- New Engine 2004
- New Engine 2007+

Approximate NOx Emissions (g/gallon)

- Truck
- Rail
- Water (barge)
Per Engine PM Emission Rates

Approximate PM Emissions (g/gallon)

- Truck
- Rail
- Water (barge)

- Average In-Use 2004
- New Engine 2004
- New Engine 2007+
Freight Movement NOx Emissions

- Truck
- Rail
- Water (barge)

NOx Emissions (g/ton-mile)

Average In-Use 2004
New Engine Std. 2004
New Engine Std. 2007+
Freight Movement PM Emissions

- Truck
- Rail
- Water (barge)

PM Emissions (g/ton-mile)
California State Emissions

In-Use Year

NOx (tons per average day)

PM (tons per average day)

2003 2005 2010 2015 2020

Heavy Trucks NOx
Rail NOx
Heavy Trucks PM 2.5
Rail PM 2.5
Future Emission Issues

- New truck engine and fuel standards are more strict than those for rail and marine
- Truck and rail in-use emissions rates equal about 2020
- Can or will rail & marine engines meet truck-like engine standards? And do they need to?
  - Different (larger) engines
  - Ultralow sulfur fuel to enable aftertreatment devices
  - Packaging difficult for locomotive
  - Accounting for the freight efficiency of rail and water transport in setting emission standards?