Worldwide Emissions Overview

Overview of International Goods Transport

Haagen Smit Symposium 2005
Michael P. Walsh

Overview

- Freight Delivery by Mode
- Heavy Truck Emissions Controls
- Marine Emissions Trends
- Locomotive Emissions Trends

Global Freight Energy Use

MTOE

Global Freight Energy Use

MTOE

Water
Rail
Truck


0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Water
Rail
Truck

Comparison of Future Emission Standards on HD vehicles

JAPAN (Draft)  
US (2010~)  
EU (2008~)

Heavy Trucks in 2020
- Modest or No Controls
- US94/Euro 2
- US98/Euro 3
- US04/Euro 4
- US07/Euro 5
- US10/Euro 6

Heavy Duty Diesel Vehicle Emissions Trends
Long-Term Emissions Trends in the US

Diesel PM

Baseline – absent new standards
L & M = 45%

On-Highway
Nonroad
Locomotive and Marine

Calendar Year

PM (tons)

Long-Term Emissions Trends in the US

NOx

Baseline – absent new standards
Locomotive and Marine
Diesel Nonroad
Diesel Highway
Gasoline Highway

Calendar Year

NOx (tons million)

Internal Water Navigation Fuel Use

Petrojoules

National Water Borne Travel

Petrojoules

Africa
Latin America
Middle East
India
Other Asia
China
Eastern Europe
FSU
OECD Pacific
OECD Europe
OECD North America

Calendar Year


2035 2040 2045 2050

Calendar Year

1995 2000

World Sales of Marine Bunker fuels
Source: IMO 2000

International Water Borne Travel
(Bunker Fuel)

Marine Vehicle Emissions
Estimates Under Business as Usual

Source: Entec Study for EU
Pollution From Ports Compared To Other Sources

NOx Emissions
Tons per day

PM10 Emissions
Tons per day

Source: NRDC "Harboring Pollution"

MARPOL Agreement

- Annex VI Enters Into Force on 19 May
- Global cap of 4.5% Sulfur
- Special Sox Control Areas Limited to 1.5% or Sox limits
  - Baltic Sea
  - North Sea
- Ozone Depleting Substances
- NOx Limits
- Restricts PCB Incineration

Key Elements of Current Marine Diesel Program
(only applies to U.S. vessels)

<table>
<thead>
<tr>
<th>Year</th>
<th>Tier 1</th>
<th>Tier 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>Commercial (30%/25% NOx/PM ↓)</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>Tier 1</td>
<td>Commercial (30%/25% NOx/PM ↓)</td>
</tr>
<tr>
<td>2002</td>
<td>Tier 2</td>
<td>Tier 2</td>
</tr>
<tr>
<td>2004</td>
<td>Tier 2</td>
<td>Tier 2</td>
</tr>
<tr>
<td>2006</td>
<td>Tier 2</td>
<td>Tier 2</td>
</tr>
<tr>
<td>2008</td>
<td>Tier 2</td>
<td>Tier 2</td>
</tr>
<tr>
<td>2010</td>
<td>Tier 2</td>
<td>Tier 2</td>
</tr>
<tr>
<td>2012</td>
<td>Tier 2</td>
<td>Tier 2</td>
</tr>
<tr>
<td>2014</td>
<td>Tier 2</td>
<td>Tier 2</td>
</tr>
</tbody>
</table>

The amendments 2004/26/EC tightened the emission limit values for gaseous pollutants and particulate matter and extended the scope of the Directive to also cover engines for inland waterways vessels and railway locomotives and railcars. European Commission policy is to encourage a shift of transport away from roads and towards other more environmentally friendly modes including inland shipping. Thus, these modes must address their own environmental impact, and the present proposal is a part of that.

The cap of 560 kW for propulsion engines on the above (main engines, bow propellers etc.) has been removed.
EU Parliament Adopts Sulfur Limits

- 1.5% Sulfur Limit in Baltic Sea (19 May 2006) & North Sea and Channel (autumn 2007)
- 1.5% Sulfur Limit for passenger vessels between EU Ports (19 May 2006)
- 0.1% Sulfur Limit for inland vessels & seagoing ships at berth in EU ports (1/1/2010)
- 2008 Commission Review of second phase limit of 0.5%
- Current Marine fuel Spec is 5.0 percent, or 50,000 parts per million
- Will reduce SO2 emissions by 500,000 tons annually, according to Commission estimates
- 2000 fewer life years lost from long term exposure and 750 fewer deaths from short term exposure

Key Elements of Current Locomotive Program
(only applies to U.S. railroads)

<table>
<thead>
<tr>
<th>Tier 0</th>
<th>new-built in 2001</th>
<th>(35% NOx ↓)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>rebuilds of locomotives built in 1973-2001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tier 1</th>
<th>new-built in 2002-2004</th>
<th>(50% NOx ↓)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>new-built in 2005+</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tier 2</th>
<th>new-built in 2005+</th>
<th>(60/50% NOx/PM ↓)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locomotive diesel fuel</td>
<td>500 ppm &amp; fuel</td>
<td>15 ppm</td>
</tr>
</tbody>
</table>

Current Locomotive/Marine Diesels Standards are Comparable to Early 1990’s Diesel Truck Standards

- Trucks 2010
- Trucks 1991
- Locomotives Tier 2 2005
- Marine Tier 2 2004-2009

Rail Freight Movement

Energy Use - Petajoules

Thousands


Africa
Latin America
Middle East
India
Other Asia
China
Eastern Europe
FSU
OECD Pacific
OECD Europe
OECD North America
Conclusions

• Freight Movement is Continuing To Grow Rapidly
• Heavy Trucks Are Increasingly Dominant
• PM & NOx From Heavy Trucks Are Declining Rapidly
• Marine Pollution is Increasingly Important
  – Globally
  – Coastal Regions
  – In Ports
• Locomotive Controls Also Very Modest To Date