"Don't Breathe Easy"
The Maritime Community's Bout with the Clean Air Act

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THE PORT OF VIRGINIA
Building A Brighter, Cleaner, Greener Future.

September 2010
# 3 Categories of Marine Diesel Engines

<table>
<thead>
<tr>
<th>Category</th>
<th>Displacement/ Cylinder (D)</th>
<th>Basic Engine Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1-2</td>
<td>D &lt; 5 dm³ *</td>
<td>Land Non-road Diesel / Tug Boats</td>
</tr>
<tr>
<td>Tier 3-4</td>
<td>D &lt; 7 dm³</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5 dm³ ≤ D&lt;30 dm³</td>
<td>Locomotive – Tug Boat</td>
</tr>
<tr>
<td>2</td>
<td>7 dm³ ≤ D&lt;30 dm³</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>D ≥ 30 dm³</td>
<td>Container vessels, oil tankers</td>
</tr>
</tbody>
</table>

* And power 37 kW

- Category 1 & 2: 700-11,000hp
- Category 3: 3,000 – 100,000 hp
• 1999 Marine Engine Rule
  • Engines above 37 kW (50 hp)
  • Includes Propulsion & Auxiliary Engines
  • Adopted Tier 1 standards for Non-road, Tugs & Locomotives
    • Ocean Vessels – voluntary compliance
  • Foreign Trade Exemption
    • U.S. Vessels operate >75% of time outside U.S. territory (200 mi)
  • Voluntary MARPOL Annex VI NOx standards (2000)
  • Established Tier 2 Standards (2004-2005)
• 2003 Marine Engine Rule
  • Engines above 37 kW (50 hp) including Ocean vessels
  • New marine engines only
  • U.S Flagged Vessels Only
  • Adopted Tier 2 standards for Non-road, Tugs & Locomotives – 15% Reduction
  • Equivalent to MARPOL Annex VI
  • 15% NOx reduction over 1999 rule
Marine Diesel Regulation

The graph shows the NOx limit (g/kWh) as a function of rated engine speed (rpm) for different Tier levels:

- **Tier I**
- **Tier II (Global)**
- **Tier III (NOx Emission Control Areas)**
## Tier 2 Marine Emission Standards

<table>
<thead>
<tr>
<th>Category</th>
<th>Displacement</th>
<th>CO (g/kWh)</th>
<th>NOx (g/kWh)</th>
<th>PM (g/kWh)</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>dfm³/cylinder</td>
<td>5.0</td>
<td>7.5</td>
<td>0.40</td>
<td>2005</td>
</tr>
<tr>
<td></td>
<td>Power ≥ 37 kW D &lt; 0.9</td>
<td>5.0</td>
<td>7.5</td>
<td>0.40</td>
<td>2005</td>
</tr>
<tr>
<td></td>
<td>0.9 ≤ D &lt; 1.2</td>
<td>5.0</td>
<td>7.2</td>
<td>0.30</td>
<td>2004</td>
</tr>
<tr>
<td></td>
<td>0.9 ≤ D &lt; 1.2</td>
<td>5.0</td>
<td>7.2</td>
<td>0.20</td>
<td>2004</td>
</tr>
<tr>
<td></td>
<td>0.9 ≤ D &lt; 1.2</td>
<td>5.0</td>
<td>7.2</td>
<td>0.20</td>
<td>2007</td>
</tr>
<tr>
<td>2</td>
<td>5.0 ≤ D &lt; 15</td>
<td>5.0</td>
<td>7.8</td>
<td>0.27</td>
<td>2007</td>
</tr>
<tr>
<td></td>
<td>5.0 ≤ D &lt; 15</td>
<td>5.0</td>
<td>8.7</td>
<td>0.50</td>
<td>2007</td>
</tr>
<tr>
<td></td>
<td>Power &lt; 3300 kW</td>
<td>5.0</td>
<td>8.7</td>
<td>0.50</td>
<td>2007</td>
</tr>
<tr>
<td></td>
<td>15 ≤ D &lt; 20</td>
<td>5.0</td>
<td>9.8</td>
<td>0.50</td>
<td>2007</td>
</tr>
<tr>
<td></td>
<td>Power ≥ 3300 kW</td>
<td>5.0</td>
<td>9.8</td>
<td>0.50</td>
<td>2007</td>
</tr>
<tr>
<td></td>
<td>20 ≤ D &lt; 25</td>
<td>5.0</td>
<td>9.8</td>
<td>0.50</td>
<td>2007</td>
</tr>
<tr>
<td></td>
<td>25 ≤ D &lt; 30</td>
<td>5.0</td>
<td>11.0</td>
<td>0.50</td>
<td>2007</td>
</tr>
</tbody>
</table>

Tier 1 NOx Limits Mandatory
• 2008 Marine Engine Rule
  • Category 1 and 2 Engines
  • Applies to newly manufactured and re-manufactured engines
  • Establishes Tier 3 and 4 standards
    • 90% PM & 80% NOx reductions compared to Tier 2
  • 1st ever standards for remanufactured engines
    • > 800 HP
  • U.S. flagged vessels
  • Ocean vessels not included (Category 3)
• 2008 Marine Engine Rule – cont’d
  • 2009 Tier 3 Standards apply
  • 2014 – 2017 Tier 4 standards apply
    • Require use of ultra low sulfur diesel fuel (15 ppm)
    • Available 2012
  • GHG reductions with Tier 4
    • HC & CO
# Tier 4 Marine Emission Standards

<table>
<thead>
<tr>
<th>Category</th>
<th>Power</th>
<th>NOx</th>
<th>HC</th>
<th>PM</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 &amp; 2</td>
<td>kW</td>
<td>g/kWh</td>
<td>g/kWh</td>
<td>g/kWh</td>
<td></td>
</tr>
<tr>
<td>P≥ 3700</td>
<td></td>
<td>1.8</td>
<td>0.19</td>
<td>0.40</td>
<td>2014</td>
</tr>
<tr>
<td>P≥ 3700*</td>
<td></td>
<td>1.8</td>
<td>0.19</td>
<td>0.06</td>
<td>2016</td>
</tr>
<tr>
<td>2000 ≤ P &lt; 3700</td>
<td></td>
<td>1.8</td>
<td>0.19</td>
<td>0.04</td>
<td>2014</td>
</tr>
<tr>
<td>1400 ≤ P &lt; 2000</td>
<td></td>
<td>1.8</td>
<td>0.19</td>
<td>0.04</td>
<td>2016</td>
</tr>
<tr>
<td>600 ≤ P &lt; 1400</td>
<td></td>
<td>1.8</td>
<td>0.19</td>
<td>0.04</td>
<td>2017</td>
</tr>
</tbody>
</table>
I-64 Express Barge Service Started in 2008

- Weekly service between NIT and Port of Richmond
- 12,000 trucks removed from highways and local roads
- Tier II Engines – ULSD

184,615 gallons of diesel fuel saved annually

$550,000 annual reduction in fuel costs

30-40% reduction in emissions compared to moves via truck
“Green” Locomotives

Hybrid and Ultra-Low Emission Locomotives

- 1 - Hybrid Yard Switcher (2,000 HP)
- 2 - Eco-Motive GenSet Yard Switchers (2,000 HP)

  - 50% Reduction in Fuel Consumption (Hybrid)
  - 80% Reduction in NOx Emissions
Emission Inventory Update

NOX
Regional (including on-terminal) NOX Emissions Over Time

Source Type

- Ocean Going Vessels (OGV)
- Harbor Craft (HC)
- Container Handling Equipment (CHE)
- On-road Trucks (HDV)
- Rail (RL)
- Total

Tons per Year

- 2005
- 2009
- 2012
- 2015

Total emissions have shown a significant reduction over time.
• Foss Maritime Company - Southern California - 2009
• New Build or Retrofit
• $8 Million vs 45 million conventional
• 44% reduction NOx and PM