The Need to Reduce Marine Shipping Emissions: A Santa Barbara County Case Study

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November 2005
Ships in the SB Channel

Photo by Steve Ringman, The Seattle Times
Overview

• The problem
• Clean air planning process
• 2004 marine shipping inventory
• Regulatory efforts
• Technologies and challenges
• Demonstration project
• Conclusions
The Problem

• Over 7,200 annual traverses
• 130 miles of coastline
• Large 2-stroke engines
• Vessels burning heavy bunker fuels
• Slow turnover rates
• Majority of the vessels are foreign flagged
• Trade volumes expected to continue increasing
Typical Great Circle Route
California Coastal Waters
Clean Air Planning Process

- Attainment state and federal standards
- Develop emission inventories
- Evaluate emission control measures
- Forecast emissions
- Marine shipping contribution: Large and growing
- June 2007 – Next Clean Air Plan
Santa Barbara County NOx * Emissions Comparison

2000 Santa Barbara County NOx Emissions

- OCS- Marine Shipping: 42.71%
- On-Road Motor Vehicles: 31.17%
- Other Mobile Sources: 17.25%
- OCS Stationary Sources: 1.05%
- Area-Wide Sources: 0.61%
- Stationary Sources: 7.13%

2020 Santa Barbara County NOx Emissions

- OCS- Marine Shipping: 74.88%
- On-Road Motor Vehicles: 7.62%
- Other Mobile Sources: 8.02%
- OCS Stationary Sources: 0.92%
- Area-Wide Sources: 1.36%
- Stationary Sources: 7.10%

* NOx = Onshore + OCS
Santa Barbara County
NOx * Emission Forecast

* Percentage of total emissions from foreign and US vessels in transit

* NOx = Onshore + OCS
2004 Marine Shipping Inventory

- Over 7,200 transits
- 9% of vessels = 50% NOx emissions
- 59 vessels over 50 tons of NOx in 2004
- 92% of NOx from foreign flagged vessels
- About 19 transits per day
- About 40 tons of NOx and 3 tons of PM emitted daily
Ship Type Analysis

2004 Total NOx by Vessel Type
(Total NOx = 14,744 Tons)

- Container Ship: 84%
- Bulk: 4%
- Tanker: 3%
- Tug/Barge: 1%
- RO/RO: 1%
- Other (7): 1%
- Cargo/General: 2%

2004 Total Transits by Vessel Type
(Total Transits = 7,207)

- Container Ship: 63%
- Bulk: 9%
- Tanker: 7%
- Tug/Barge: 6%
- Cargo/General: 3%
- Auto Carrier: 8%
- RO/RO: 2%
- Other (7): 2%
Container ship
~ 30 MW (~40,000 hp)
2-stroke main engine
Port Hueneme

- "Niche" Port
  - #1 port in nation for citrus exports
  - Top ten in imports of autos & bananas
- Nearly tripled cargo weight and value between 1990 & 2001
- 35’ depth limits vessel types
- Vessel types: Reefer, ro-ro, older containerships
- About 340 calls in 2004
- About 7% of total US vehicle carrier port calls and capacity (DWT x calls) in 2004
Common Ship Types

2004 Port Hueneme Calls

- Ro-ro: 62%
- General Cargo: 34%
- Tankers: 3%
- Container: 1%

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Future?

Regulatory Efforts

IMO

- MARPOL Annex VI
  - Entered into force on May 19, 2005
  - Sets limits for SOx and NOx from vessels built or modified after 1/1/2000
  - Currently 27 countries have ratified
  - US, Canada & Mexico have NOT ratified treaty yet
  - By 2007 revisions that will be considered include:
    - PM, VOC, GHG limits & tougher NOx & SOx limits
    - In-use engine applicability

US EPA

- Category 3 Engine Rulemaking
  - Tier 1 standards = IMO standards
  - Tier 2 standards expected 2007
- SECA application development (2007 submittal)
Regulatory Efforts

California Air Resources Board (ARB)

- **Air Toxic Control Measures (ATCM)**
  - Developing aux. engine ATCM (Dec. 2005)
  - Cargo handling equipment ATCM (Dec. 2005)
  - Cruise ship on-board Incineration ATCM (Nov. 2005)
  - Frequent flyer vessel ATCM (2006)

- **Research**
  - CA ocean-going vessel emission inventory (Fall 2005)
  - Modeling & Health / Ecological impact (Spring 2006)
  - SECA development collaboration with EPA
Potential Control Technologies

• Water based controls
  ◆ Emulsified fuels
  ◆ Water injection
  ◆ Humidification
• Slide valves
• Exhaust gas recirculation
• Selective catalytic reduction
• Cleaner fuels, oxidation catalysts
Technology Challenges

- Quick installation
- Reliability
- Low maintenance
- Safety
- Pollutant trade-offs
- Fuel consumption
- Industry buy-in
Demonstration Project

Objectives
• Demonstrate emission controls
• Develop support for potential economic incentive programs
• Develop in-use testing protocol

Participants
• U.S. EPA, MARAD
• ARB, Ports, CA Air districts
• Ship operator
• Engine manufacturer
Technology: Slide Valves

- Already in use
- Reduce PM by 30 - 50%
- Fuel efficient design
- Cost-effective
- Easy to install
- $96,000 for 22 valves
Technology: Water Emulsion System

- Reduce NOx up to 30%
- Being considered for Main engine
- Designed by engine manufacturer
- Small loss in power possible
- Approx. $555,000 for the system
- Cost-effective

# Projects Evaluated

<table>
<thead>
<tr>
<th>Ship Name</th>
<th>Ship type</th>
<th>Built</th>
<th>Power (hp)</th>
<th>DWT* / TEU</th>
<th>Engine</th>
<th>Control technology</th>
<th>Hardware Cost</th>
<th>NOx reductions</th>
<th>PM reductions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matson/ R.J. Pfeiffer</td>
<td>Container</td>
<td>1992</td>
<td>34,160</td>
<td>28,555 / 2,319 TEU</td>
<td>MAN B&amp;W 8L80MC</td>
<td>Seaworthy water emulsion system</td>
<td>$400,000</td>
<td>25%-35%</td>
<td>n/a</td>
</tr>
<tr>
<td>APL CHINA</td>
<td>Container</td>
<td>1995</td>
<td>66,398</td>
<td>66,520 / 5,418 TEU</td>
<td>MAN B&amp;W 11K90MC-C</td>
<td>MAN B&amp;W water emulsion system and slide valves</td>
<td>$742,300</td>
<td>25%</td>
<td>25-35%</td>
</tr>
<tr>
<td>APL KOREA</td>
<td>Container</td>
<td>1995</td>
<td>66,398</td>
<td>66,520 / 5,418 TEU</td>
<td>MAN B&amp;W 11K90MC-C</td>
<td>MAN B&amp;W water emulsion system and slide valves</td>
<td>$742,300</td>
<td>25%</td>
<td>25-35%</td>
</tr>
<tr>
<td>APL JAPAN</td>
<td>Container</td>
<td>1995</td>
<td>66,398</td>
<td>66,520 / 5,418 TEU</td>
<td>MAN B&amp;W 11K90MC-C</td>
<td>MAN B&amp;W water emulsion system and slide valves</td>
<td>$742,300</td>
<td>25%</td>
<td>25-35%</td>
</tr>
<tr>
<td>SeaRiver Long Beach</td>
<td>Tanker</td>
<td>1987</td>
<td>31,650</td>
<td>214,682/3 TEU_n/a</td>
<td>Sulzer 8RTA84</td>
<td>Seaworthy water emulsion system for engine + boiler</td>
<td>$442,500</td>
<td>25%-35%</td>
<td>30% (boiler)</td>
</tr>
</tbody>
</table>

* Deadweight Tonnage (DWT): The weight in tonnes (1000 kg) of cargo, stores, fuel, passengers and crew carried by the ship when loaded to her maximum capacity.
Challenges

- Ship owner participation
- Funding sponsors & cooperative agreements
- Project scope & priorities
- Limited emission test data available
- Vessel down time and schedule delays
- Vessel route stability
- Project life
Conclusions

- Marine shipping emissions are significant & growing
- Regulatory efforts largely ineffective to date
- Cost effective control technologies available
- Significant capital expenditure
- Technology & implementation challenges
- Pursuing a partnership approach
- Once proven, additional partnerships and incentives programs needed