



THE MARITIME ADMINISTRATION'S ENERGY AND EMISSIONS PROGRAM

**An Industry/Government
Cooperative**

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Maritime Administration**

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Center for Climate Change and Environmental Forecasting

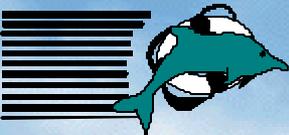


ROSEMOUNT ANALYTICAL

The Partners



CASRM
Center for Advanced Ship Repair and Maintenance



PRIME, Inc.



Federal Transit Administration



Contents

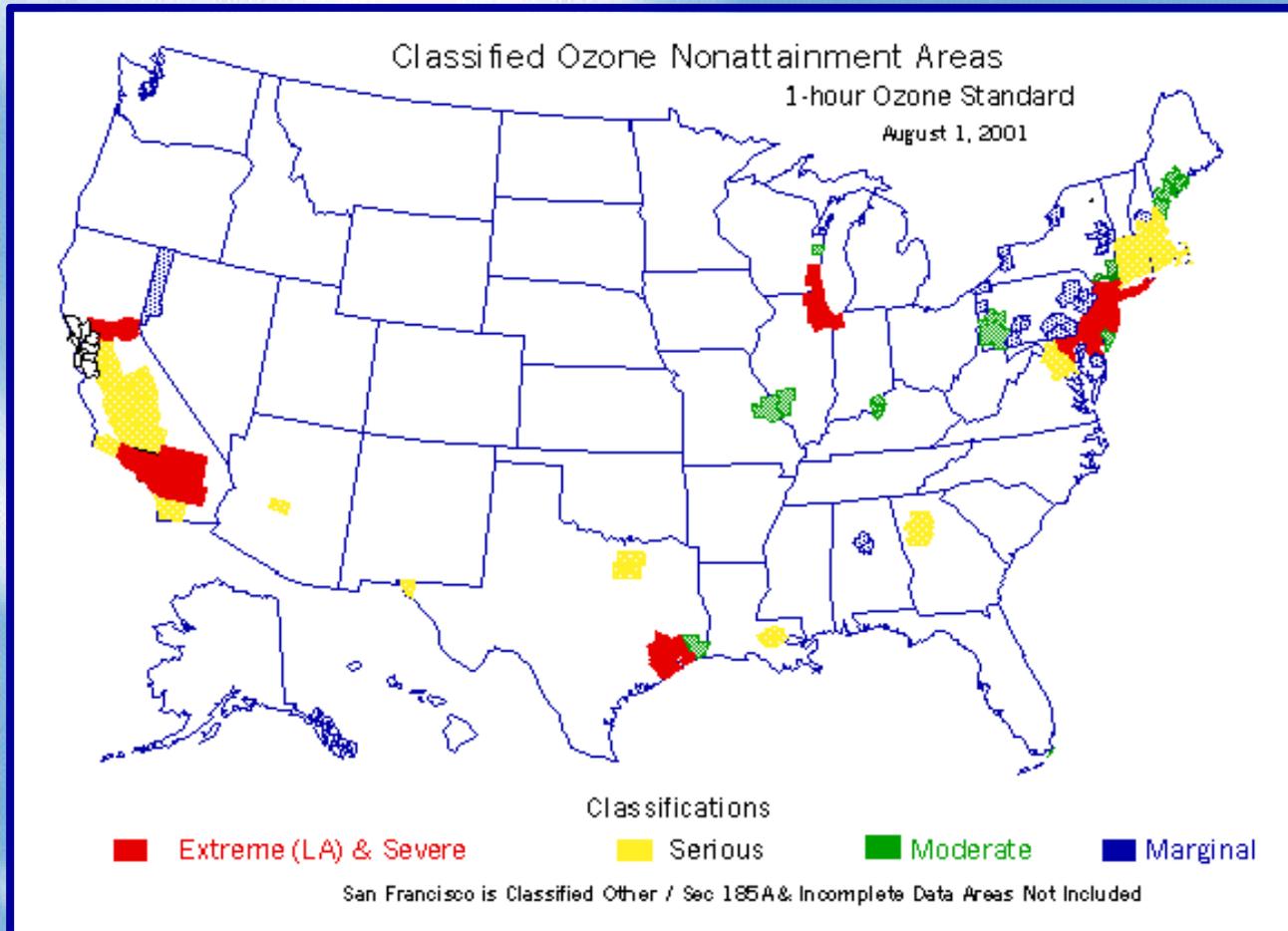
- Issues Impacting Marine Industry
- Program Objective
- Program Plan and Status of Projects
 - Baseline Emission Monitoring
 - Diesel Retrofits
 - Alternative Fuels
 - Advanced Technology - Fuel Cells
 - Supporting Studies
 - Planned Studies and Demonstrations
- Conclusion

Issues Impacting Commercial Marine Industry

Issues Impacting Marine Industry

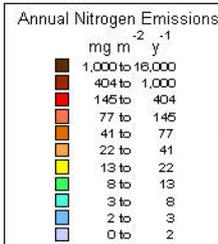
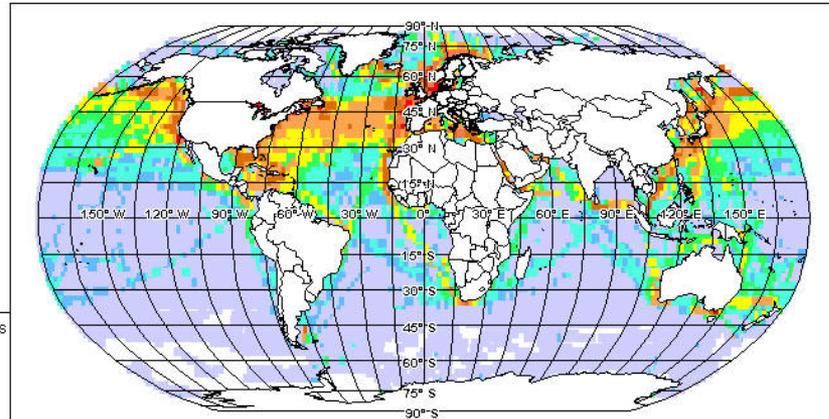
- Marine Vessels Pollute the Air
 - For Twenty-Five Years - Attention Paid to Land Transportation
 - Now Maritime in the Spotlight
- International Maritime Organization (IMO) - Seeking to Ratify Annex 6 - Retroactively Influencing New Marine Engines
- CY 99 & 02 - Environmental Protection Agency (EPA) Marine Engine Regulations
- State Air Quality Plans
 - So. Cal. Voluntary Vessel Slow Down (NOx), Port Vol. to Increase 3X by '20
 - Alaska Cruise Ships (Visible Smoke), Cruise Vessels on Shore Power
 - Port of Houston & State Implementation Plan (NOx)
 - Port of New York Dredging Issues (NOx), Fed Project Must Conform with SIP
- Highway Congestion and Fast Ferries (Effects on Air Quality)

Ozone Nonattainment Areas

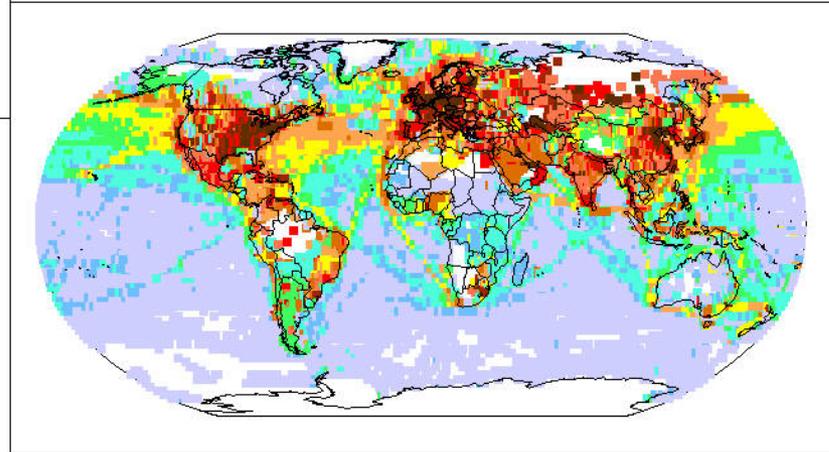


Geographic Distribution of Global Nitrogen Emissions

SEA nitrogen
data only



SEA nitrogen
data with GEIA
data



Scale is defined to increase resolution for ocean regions; see Corbett, J. J. and P. S. Fischbeck (1997). "Emissions From Ships.. *Science* **278**(5339): 823–824; and Corbett, J. J., P. S. Fischbeck, et al. (1999). "Global Nitrogen and Sulfur Emissions Inventories for Ongoing Ships.. *Journal of Geophysical Research* **104**(D3): 3457–3470

Program Objective

Program Objective

- Promote the application of energy efficient, low emission technologies to marine power plants

- **Outcomes**

- Protect Human and Natural Environment;
- Reducing Dependence on Foreign Oil and;
- Improving Competitiveness of Marine Transportation

Strategies for Achieving Objective

- Identify and study technologies to determine their applicability to marine applications
- Demonstrate energy and emission technologies on marine platforms
- Become the US repository of national and international maritime related energy and emission information
- Publicize and support useful energy and emissions findings via outreach programs

Program Plan and Status of Projects

Five Year Program Plan Overview

- **Baseline Performance and Emission Testing**
 - Existing Vessel Data and Measurement Techniques
- **Diesel Retrofits**
 - Emulsified Fuel, Water Injection, SCR, Particulate Traps
- **Alternative Fuels**
 - Natural Gas, Biodiesel, Hydrogen, Synthetic Diesel
- **Advanced Technologies**
 - Fuel Cells, High Efficiency Gas Turbines
- **Supporting Studies**
 - Technology Evaluations, Incentives and Emission Trading
- **Industry Outreach**
 - Newsletter, Conferences, Website, and Presentations

Five Year Program Plan

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Demonstrations					
Baseline Fuel Efficiency and Emissions Measurements					
FEEM 1 - Car, Bus and Ferry Comparison					
FEEM 2 - Natural Gas vs Diesel Fuel - Ferry					
FEEM 3 - New SF Diesel Ferry					
FEEM 4 - Pre and Post Reengining of Vessel					
FEEM 5 - Gas Turbine					
Diesel Technologies					
DT 1 - Particulate Matter Filter					
DT 2 - Water Injection System					
DT 3 - Selective Catalytic Reduction					
Alternative Fuel Technologies					
AF 1 - LNG - New Ferry Construction					
AF 2 - CNG - Ferry Conversion					
AF 3 - Dual Fuel - Towboat, New Construction					
AF 4 - Synthetic Fuel Oil - Engine Modification					
AF 5 - Hydrogen Internal Combustion Engine					
AF 6 - Biodiesel with NO _x Reduction Technology					
Fuel Cell Technologies					
FC 1 - Natural Gas Fuel Cell - Research Vessel					
FC 2 - Natural Gas Fuel Cell - Commercial Vessel					
Studies					
Vessel Natural Gas Conversion Design Feasibility Study					
Highway/Ferry Integration Study					
Standardized Protocol Development					
Technology Surveys and Vessel Compatibility Analysis					
Emissions Trading Economics					
Industry Outreach					
Workshops and Conferences					
Website and Technology Database Development					

Diesel Engine Baseline Emission Measurements (Completed)



- Two Vessels
 - San Francisco and Norfolk
- Both 2 Stroke Detroit
- One Bench Grade Equip.
- One Handheld Equipment
- Measured at 4 Speeds
 - NO_x 12 - 30 g/bhp-hr range
- WTA Tested 4 Stroke Eng
 - NO_x Lower than Expected

Diesel Retrofit Technology Effectiveness (From Completed Literature Search)

Control Technology	% NO _x Reduction	Fixed Costs – Hardware, Installation, Design	Annual Costs – Maintenance, Operating, Fuel	NPV Costs (15% over 23 years)	Cost-effectiveness (\$/ton NO _x)
Selective catalytic reduction	81	\$285,000	\$30,000	\$477,000	\$5,889
Water/fuel emulsion	42	\$119,000	\$32,000	\$324,000	\$7,714
Injector upgrade	16	\$41,000	\$24,000	\$195,000	\$12,188
Water in combustion air	28	\$134,000	\$36,000	\$364,000	\$13,000
Fuel pressure increase	14	\$36,000	\$29,000	\$222,000	\$15,857
Aftercooler upgrade	10	\$12,000	\$27,000	\$185,000	\$18,500
Injection timing retard	19	\$250	\$57,000	\$365,000	\$19,211
Engine derating	14	\$34,000	\$55,000	\$386,000	\$27,571
Exhaust gas recirculation	34	\$3,500	\$2,640,000	\$16,896,000	\$496,941

Corbett and Fischbeck study for large vessels