THE MARITIME ADMINISTRATION'S ENERGY AND EMISSIONS PROGRAM

An Industry/Government Cooperative

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Maritime Administration

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The Partners

U.S. DEPARTMENT OF TRANSPORTATION
Center for Climate Change and Environmental Forecasting

ABS

U.S. COAST GUARD

ROSEMOUNT ANALYTICAL

NETL

RSPA research and special programs administration

BROOKHAVEN NATIONAL LABORATORY

UNIVERSITY OF DELAWARE

ACTA NON VERBA

CASRM
Center for Advanced Ship Repair and Maintenance

bp marine

AQMD

Region 9

PRIME, Inc.

THE PORT OF LONG BEACH

MIDAS

BLUE & GOLD FLEET

NAVSEA PHILADELPHIA
Ships Systems Engineering Station

California Air Resources Board

Seaworthy

WestVirginiaUniversity

gti

Red and White Fleet
SINCE 1892 – THE SAN FRANCISCO SIGHTSEEING TRADITION

Matson

U.S. Department of Transportation
Federal Highway Administration

Port of Houston Authority

SUREPOWER™ CORPORATION

Santa Barbara County Air Pollution Control District

EPA United States Environmental Protection Agency

WATER TRANSIT AUTHORITY

HRT Hampton Roads Transit

Federal Transit Administration

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- Program Plan and Status of Projects
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  - Diesel Retrofits
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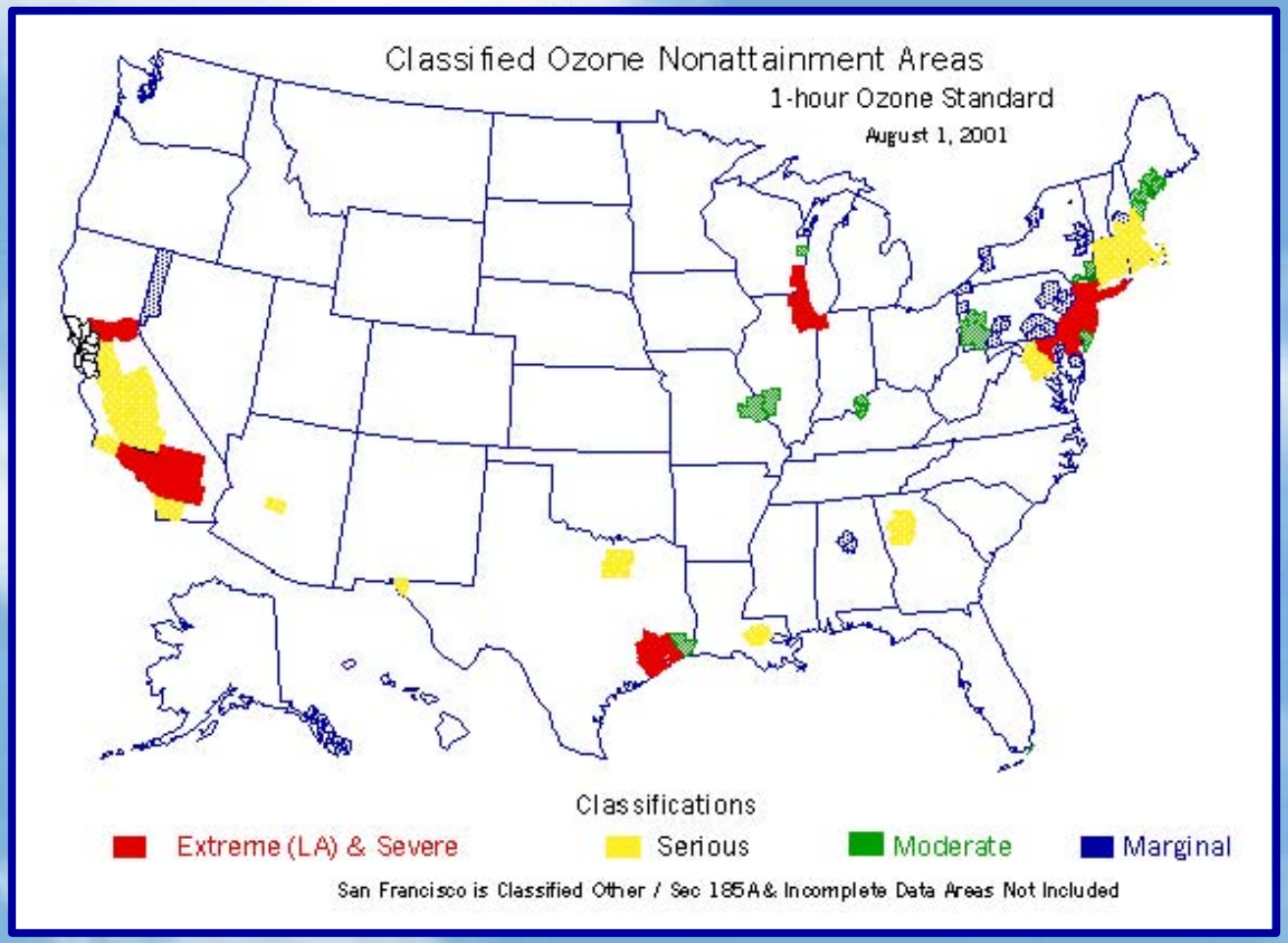
- Conclusion

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)

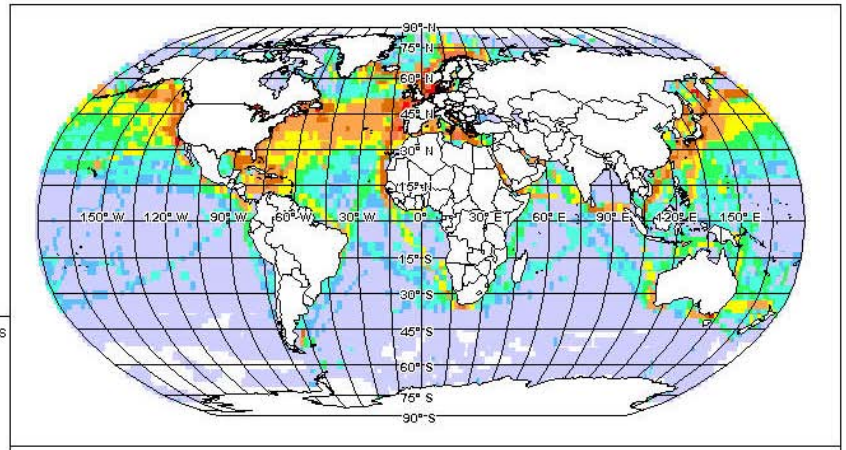
Ozone Nonattainment Areas

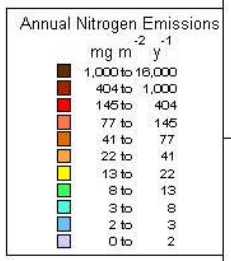


Source: EPA Office of Air & Radiation, AIR Database

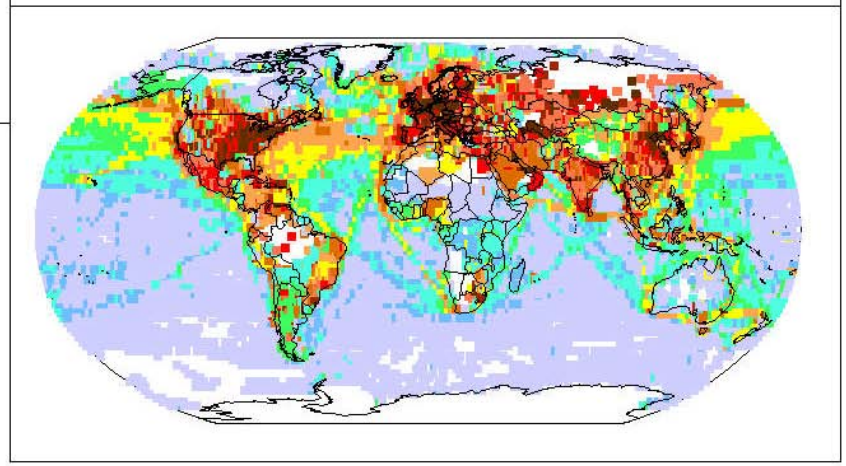
Geographic Distribution of Global Nitrogen Emissions

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 Oceangoing 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

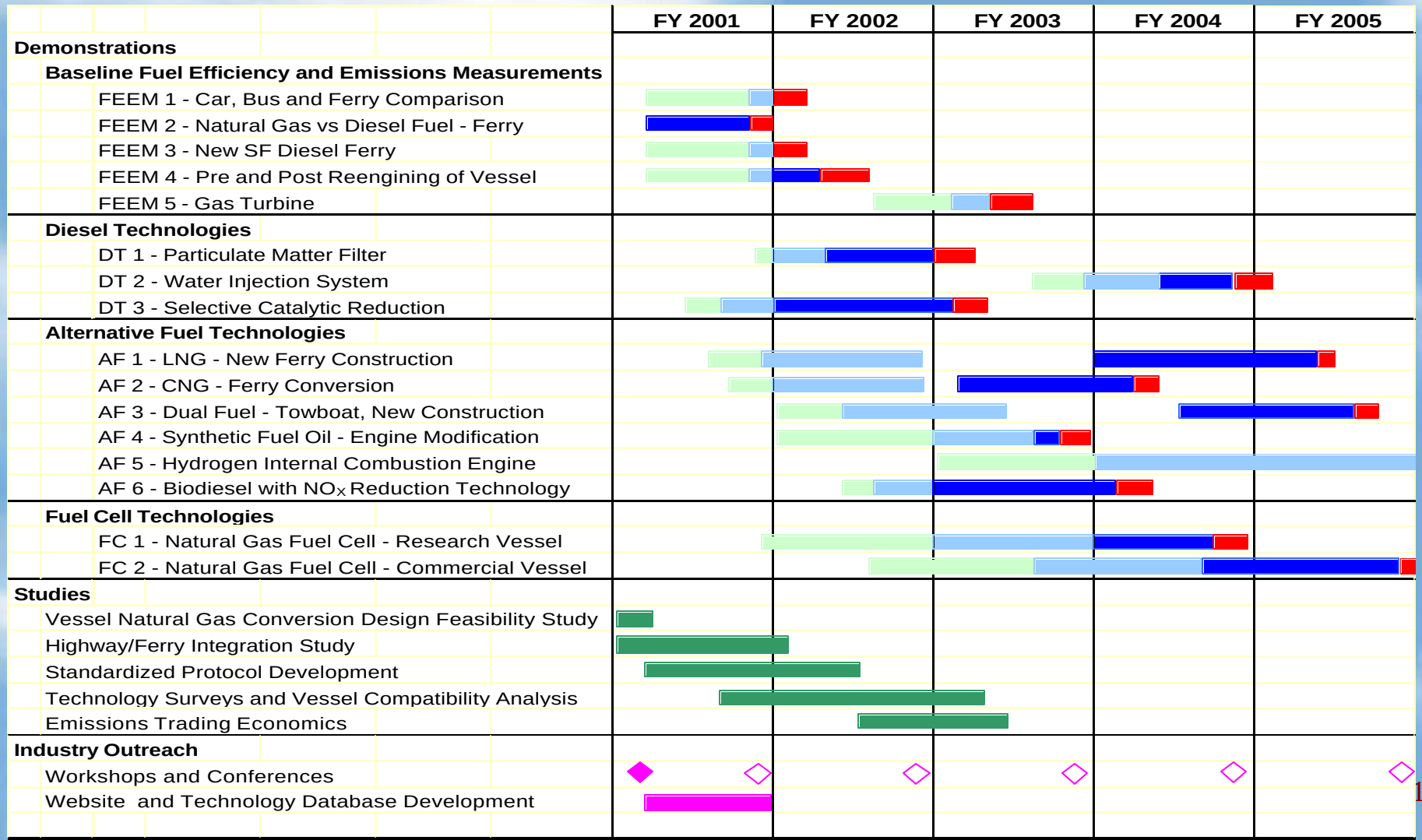
- Identify and study technologies to determine their applicability to marine applications
- Demonstrate energy and emission technologies on marine platforms
- Become the US repository of national and international maritime related energy and emission information
- Publicize and support useful energy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



Diesel Engine Baseline Emission Measurements (Completed)

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