Recent Diesel Engine Emission Mitigation Activities of the Maritime Administration Energy Technologies Program

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Maritime Administration (MARAD) Mission and Goals

- **MARAD** - An agency of the U. S. Department of Transportation
- **Mission** - Responsible for fostering the development and maintenance of a commercial and defense oriented U. S. Merchant Marine
- **Goals** - Improve:
  - Commercial mobility
  - National security
  - Energy and Environment
Presentation Contents

- “Why a marine Energy Technologies program?”
- Brief overview of the program plan
- Activities since DEER 2002
  - General
  - Two ferry retrofit projects
  - Marine emission measurements; two protocol studies
  - Newsletters
- Contact information
Why a Marine Energy Technologies Program?
“Why a Program?”
Recent Emission Pressures

- Maritime in spotlight
- IMO Annex 6 regulations
  - NOx and Sulfur limits effective if:
  - Forecasted to be ratified in 2004
- EPA regulations
  - New category 1, 2 engines (1999)
  - New category 3 engines (2002)
  - NOx, HC, CO, and PM
- CARB regulation
  - Ferries use hwy diesel by 2007
- Ozone Nonattainment Areas
- Public pressure

U.S. Ozone Nonattainment Areas
Why a Program?
Growing Marine Emissions
Santa Barbara NOx Example

Marine Shipping
Other Mobile
On-Road Mobile
Areawide
Stationary Sources

NOx Tons per Day
Program Overview
Overview - Program Objectives

- Investigate and demonstrate the potential for new technologies and fuels to improve marine power plant efficiency and to reduce air emissions
- Disseminate energy technology and related policy information to the maritime community
Overview - Program Plan

- Baseline performance 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
Overview - Partners

Mariflite Ferries

Center for Advanced Ship Repair and Maintenance

Federal Transit Administration

WATER TRANSIT AUTHORITY

Hampton Roads Transit

Port of Houston Authority

United States Environmental Protection Agency

Santa Barbara County Air Pollution Control District

SurePower Corporation

Blue & Gold Fleet

West Virginia University

Center for Climate Change and Environmental Forecasting

Air Resources Board

U.S. Department of Transportation

U.S. Coast Guard

Navsea

ABS

Maritime Administration

Research and Special Programs Administration

U.S. Department of Energy

University of Delaware

CASRM

BP Marine

BP Marine

EPA

Seaworthy

Red and White Fleet

Port of Long Beach

The Port of Los Angeles

Center for Advanced Ship Repair and Maintenance

PRIME, Inc.

MIDAS
Activities Since DEER 2002
Activities - General

- Ongoing Ferry Retrofit Projects - See slides
- Emission Measurement Protocol Studies - See slides
- NYSERDA NYC Commercial Ferry Project
  - Technology evaluation and demo w/commercial operators
  - Assisting NYSERDA, NYC DOT and FTA
- Engine and Emission Inventory Literature Search
  - Developing web-based “facts and figures” reference site.
- Large Vessel Retrofit Project
  - Assisting southern California regulators and vessel operators
  - 1st operator selected onboard fuel-emulsification technology
  - Other operators & Transport Canada interested
Activities - Ferry Retrofit #1
Water Injection and Ultra Low Sulfur Diesel

- Technologies
  - Combustion Air Water Injection System (WIS)
  - 15 PPM Sulfur Diesel

- Engine Type
  - DD 12V92 TA, 2 Stroke
  - 1050 HP at 2300 RPM
  - Long runs at cruise speed

- Partners
  - SCX Ferries, DOE, NREL, West Virginia University

SCX Ferry - MV WESTFOIL
Modified Hydrofoil Design
Activities - Ferry Retrofit #1
Test Results

- Diesel sulfur samples
  - 4000 ppm baseline
  - 400 ppm ULSD (contam’?)

- Specific NOx reduction
  - At cruise speed
    - WIS reduced by 10%
    - WIS (+) ULSD by 17%

- Specific PM reduction
  - ULSD reduced by 42%

- Negligible power loss
- ULSD has higher cost

Relative Brake Specific NOx & PM @ Cruising Speed

- Marine Diesel
- Marine Diesel w/ WIS
- ULSD
- ULSD w/ WIS

Legend:
- BSNOx
- BSPM
Activities - Ferry Retrofit #2
Selective Catalytic Reduction & ULSD/Biodiesel Blend

- Seven SI ferries total
- Pilot on Austin Class vessel
  - (2) Cat 3516 Engines
- SCR for NOx >70% reduction
- Offset NOx - vice harbor dredges
  - Measurement protocol required
- ULSD/biodiesel blend
  - Vessel uses 3000gal/day
  - 7 vessels = 3,000,000 gal/year
- Sponsors - PANY&NJ, NYC DOT
- Contractors - MJ Bradley & WVU
Activities - Studies  
Measurement Protocols  
Ten Programs - Ten Methods?

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What level of accuracy/repeatability required?

* - Future Planned Measurements
Activities - Studies
Measurement Protocols
Marine Unique Issues

- Environmental
  - Sea
  - Ambient
  - Hull fouling

- Equipment
  - Engine types
  - Wet exhaust installation
  - Fuel
  - Space

- Operational
  - Payload
  - Maneuvering
  - Steady State Modes
  - In-service

- Methodology
  - Test cycle
  - Instrumentation

- Safety
  - Calibration gases
Activities - Studies
Measurement Protocols
Duty Cycle Vs Lab Test Cycle

Norfolk Ferry Actual Duty Cycle
Activities -
Measurement Protocols
Two Related Studies

- **Vessel Engine Emission Measurement Guide**
  - James Corbett of UDEL

  **Describes**
  - Regs and policy background
  - Motivations for testing
  - Fundamentals of emission testing
  - Existing standard protocols
  - How to specify, organize data

  **Recommends**
  - MARAD provide clearinghouse of marine emission data.

- **Development of Universal Measurement Protocol**
  - MEETS Conf., 9 Authors

  **Explores**
  - Need for Standard Marine Protocols
  - Marine measurement challenges
  - Potential methods and instrumentation
  - Areas needing further research

  **Recommends**
  - Establishment of panel to investigate normalization of onboard marine measurements
Activities - Newsletters

- Technologies - Diesel eng’s, fuel cells, alt fuels, new regs …
- Contributions - Public, private, and international organizations
- Available – Electronically
Website and Contact Info

- Website - www.marad.dot.gov/nmrec/
  - Link to “Energy Technologies”
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