

# Diesel Retrofit Technologies Installed (Completed)



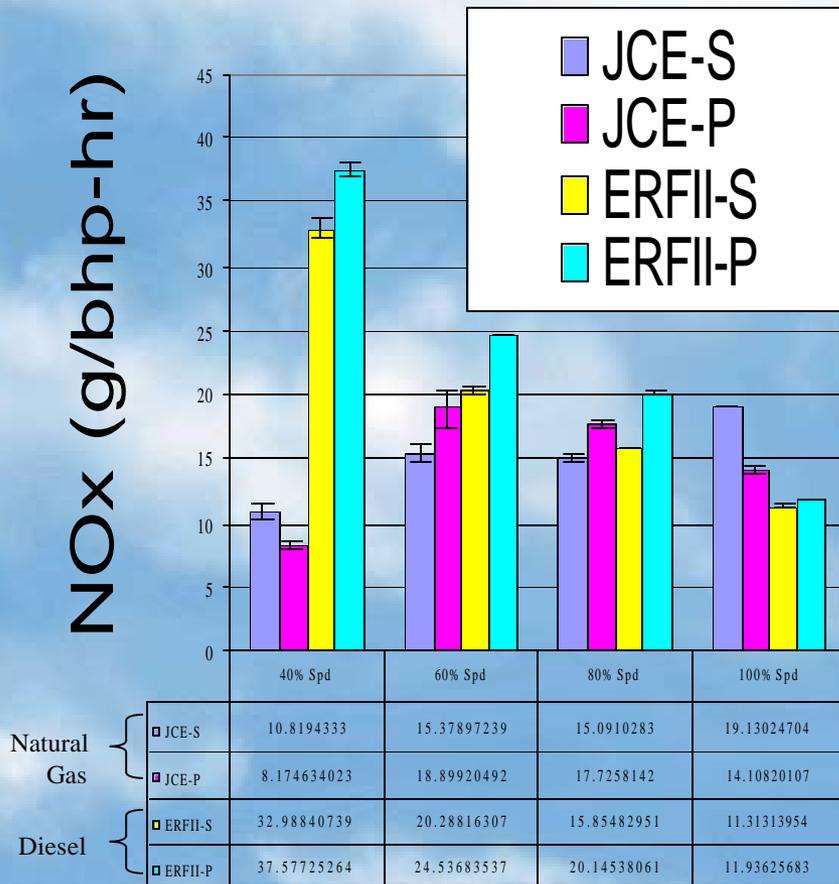
- Water in Air System
  - 24% NOx Reduction
  - No PM Reduction
  - No Fuel Penalty
- Emulsified Fuel (WTA)
  - 37% NOx Reduction
  - 42% PM Reduction
  - -----
  - (Port of Houston)
  - 24 – 33% Nox Reduction
  - 25% Fuel Penalty ?
  - -----
  - (CARB Certified)
  - 14% Nox, 63% PM

# Alternative Fuels - Natural Gas (Two Projects Completed)



- Regulatory Approved Conversion Design
  - KINGS POINTER - USMMA
  - ABS and USCG Review
  - CAT Diesel Conversion Needs Inlet Gas Valves
- Comparative Emission Tests
  - Diesel vs Natural Gas
  - Norfolk Sister Ferries

# Natural Gas vs Diesel Comparative Test Results



- No NOx Reduction for Natural Gas
  - Except at slow speed
  - FYI - Studies project 1.3 g/hp-hr
- HCs High for Natural Gas
  - Methane up the stack
- PM Low for Natural Gas
- Fuel Penalties for Natural Gas
  - Added vessel weight
  - Higher fuel costs
  - Lesser efficiency
- High Conversion Capital Costs
- Right Engine for Application?

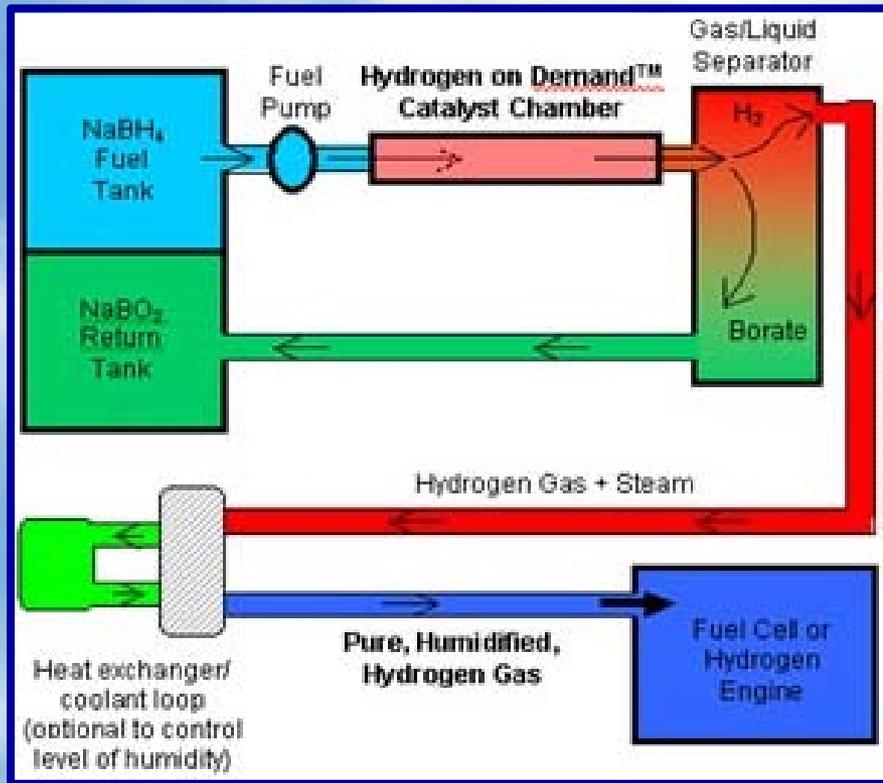
ERF II - Diesel, JCE - Natural Gas

# Alternative Fuel - Biodiesel (Completed)



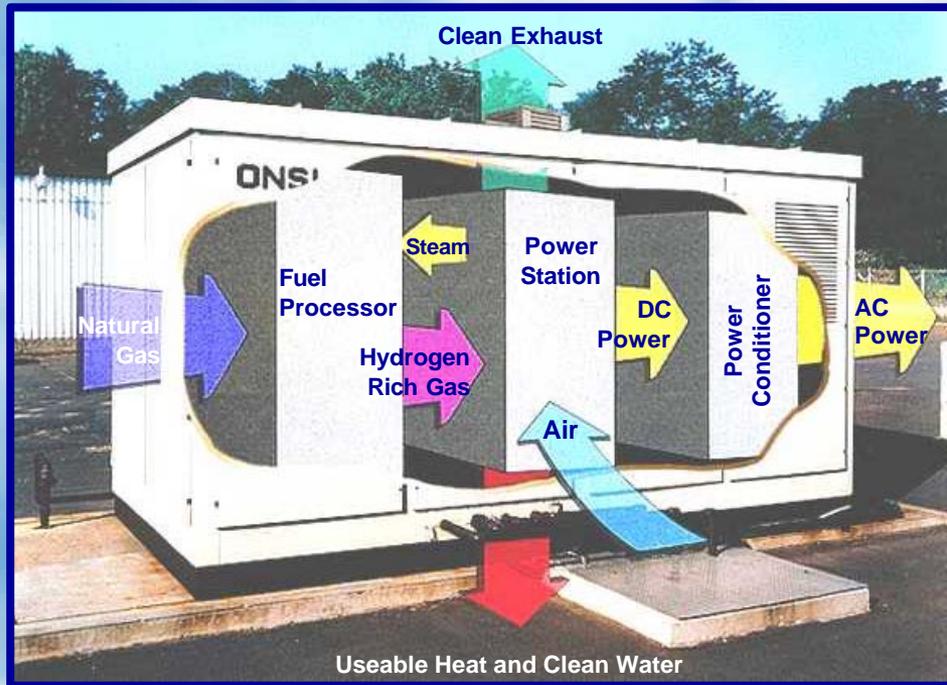
- San Francisco Bay Ferry
- Soy Based Biodiesel
- Renewable, SO<sub>2</sub> & CO<sub>2</sub> Friendly
- 20% Biodiesel
  - Nox Increase 10%
- 100% Biodiesel
  - NOx increase 24%
  - PM reduction 50%
  - Other Pollutants = Diesel Fuel
  - Combined w/Air Humidification
    - NOx reduced 12%
  - Fuel Penalty \$.40/gallon

# Alternative Fuel - Sodium Borohydride System (Regulatory Analysis Completed)



- Liquid Hydride
- High Energy Storage
- Benign Liquid Borax w/ H
- Separate Hydrogen via Catalyst Chamber
- Feasible for Fuel Cell and I.C. Engines
- Technically Viable but
  - How High ?? X Diesel Cost
  - Recycling Issues
  - Expensive/Rare Catalyst

# Advanced Technology - Fuel Cell Marine Electrical Load Testing (Completed)



- 400 kW Plants (2 - 200s)
- Phosphoric Acid Fuel Cells
- Flywheel for Load Changes
- ABS, USCG, IEEE Gen Tests
  - Voltage Regulation
  - Frequency Regulation
  - Over-current
- Test Successful
- Flywheel and Power Conditioning Incur Efficiency Penalty

# Supporting Studies - Car and Ferry Emission Comparisons (Completed)

- Study @ [www.calstart.org](http://www.calstart.org), San Fran
- Cars getting cleaner for 30 yrs
- Use of ferries with technologies can improve area air quality
- Esp. lower speed ferries with treatment
- High speed ferries NOx/PM challenged
  - Very high horsepower required
  - People drive cars to terminal
  - Often at 50% passenger capacity
- In California – Many new designs will be looking to new techs. or alternative fuels



# Supporting Studies - Emissions Measurement Protocol (In Progress)



- Which Protocol for Which Application
- International, Federal, State Agency
- Full Bench Test or Small Scale
- Transient vs Steady St
- University of Delaware
- Completion FY 03

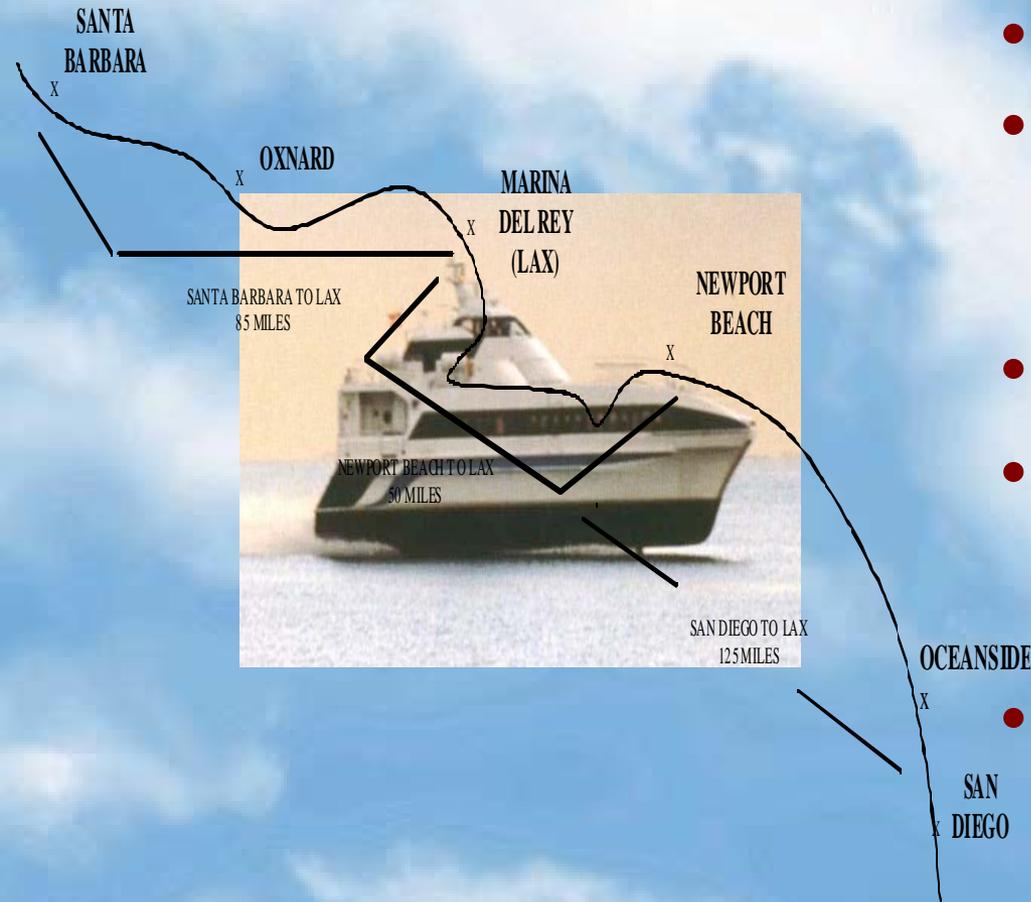
# Planned Studies & Demonstrations - Navy Engine Five Fuels & Technologies



- NAVSEA Philadelphia
- Commence FY 03
- Fuels - Nato F76, JP-5, Synthetic Diesel, Biodiesel, Special Blend
- Technologies - Air Humidification, Clean Cam, Small Sac Volume, Particulate Trap, Additive
- MARAD is One Co-Funder of Many

# Planned Studies and Demonstrations

## - Hydrofoil Ferry Diesel Retrofit



- SCX Ferries San Diego
- Department of Energy and West Virginia University
  - Emission Testing
- One Year Demo
- Leased Hydrofoil
  - (4) Two-Stroke Detroit Diesels
  - Wet exhaust system
- Two Technologies?
  - Air Fumigation
  - Low Sulfur Diesel

# Planned Studies and Demonstrations

## - Ultra-Low Emission Ferry Design



- Discussions with:
  - SCX, DOE, AQMD, GTI, etc
- High Speed / Hydrofoil
- Evaluate Best
  - Natural Gas, Diesel, Turbine, or Combined Plant
- Sponsoring a LNG Infrastructure Evaluation
- Results Applicable To all of CA

# Planned Studies and Demonstrations - Large Vessel Diesel Retrofit



- Discussions with:
  - DOT, SCAQMD, Ports, CARB, SBCAPCD, Operators
- Category 3 Marine Engines
  - Primarily Slow Speed
- Technologies
  - Air Fumigation, Fuel Emulsion, Manufacturer Retrofits



Survey, Install, and Test  
Technologies in FY 03

# Developing Project - Cargo Vessel Emission Trading

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- Discussions with BP, WVU, and AQMD
- Coastal Cargo Vessel Operators Need Incentives to Retrofit
- Technology could reduce NOx by 33% or so
- NOx Credits Trade at \$19,000/Ton
- If Vessel Generates 3 Tons / Visit:  
     $.33 \times 3 \times 20 \text{ (visits)} \times 19\text{K} = \$380,000/\text{yr}$
- Need to Evaluate Rules and Monitoring Requirements

# Conclusions

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- Foresee More Energy & Emission Pressures
- Technologies are Available at a Cost
- Incentives Needed to Drive Industry Implementation
- MARAD Program On Track
- Robust Outreach Effort is Underway
  - Conferences, Presentations, Newsletter
  - Web Site

*[www.marad.dot.gov/nmrec/energy&emissions](http://www.marad.dot.gov/nmrec/energy&emissions)*

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