



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

Daniel J. Gore

Program Engineer

Office of Shipbuilding and Marine Technology

Maritime Administration



Maritime Administration (MARAD) Mission and Goals



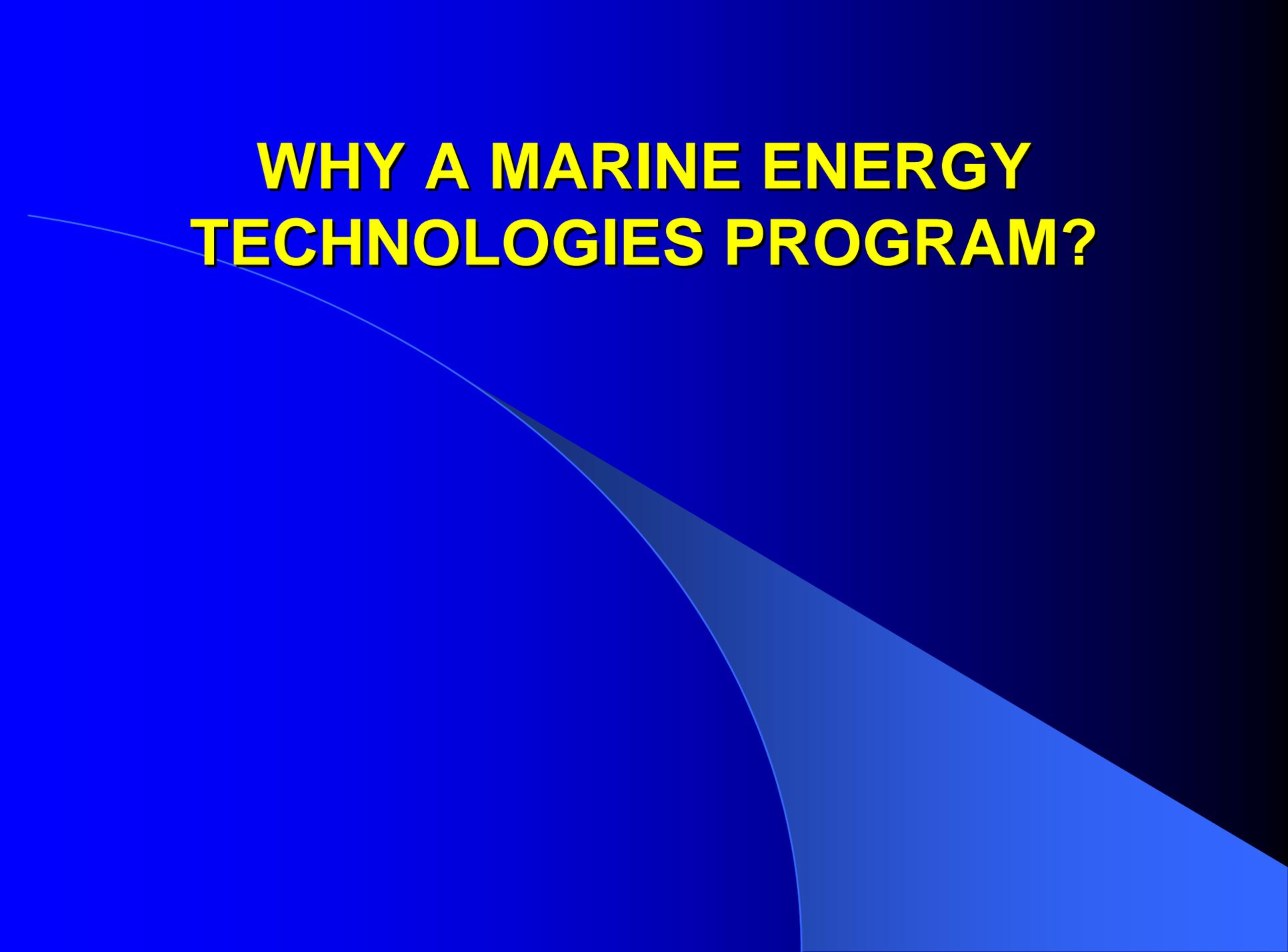
- **MARAD** - An agency of the U. S. Department of Transportation
- **Mission** - Responsible for fostering the development and maintenance of a commercial and defense oriented U. S. Merchant Marine
- **Goals** - Improve:
 - Commercial mobility
 - National security
 - Energy and Environment



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

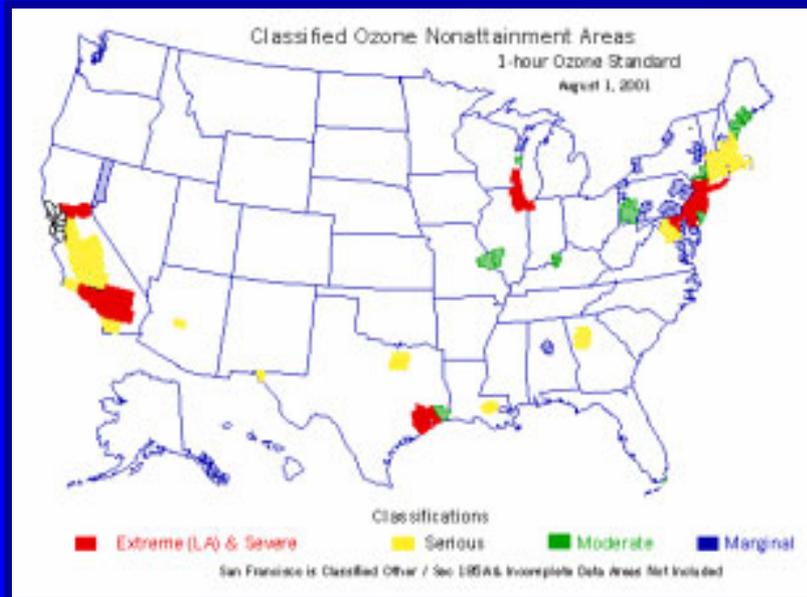
WHY A MARINE ENERGY TECHNOLOGIES PROGRAM?

The background is a dark blue gradient. A light blue curved line starts from the left edge, curves downwards and then rightwards, creating a shape that resembles a stylized wave or a modern architectural element. The text is positioned in the upper left quadrant of the image.



“ Why a Program?”

Recent Emission Pressures



U.S. Ozone Nonattainment Areas

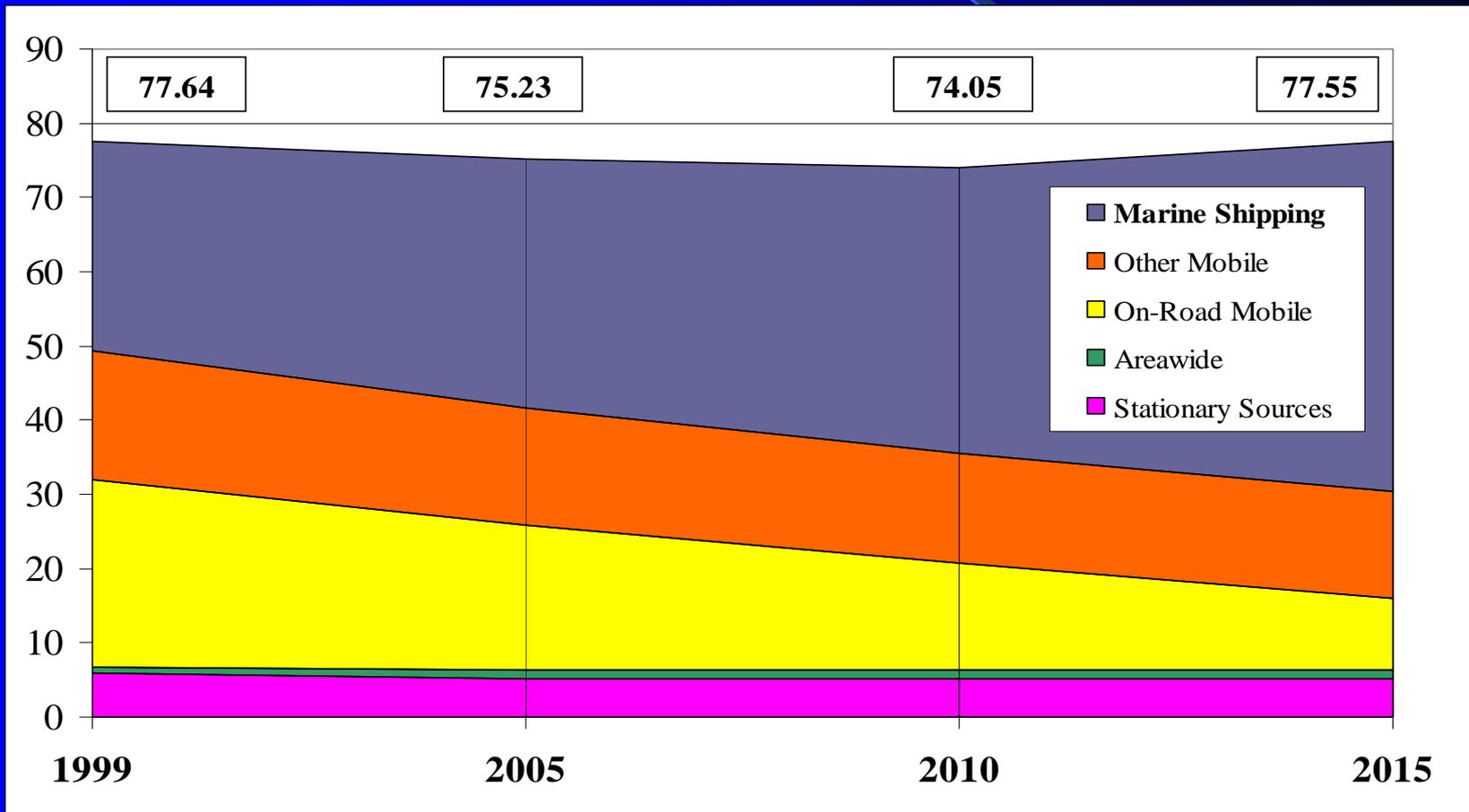
- Maritime in spotlight
- IMO Annex 6 regulations
 - NO_x and Sulfur limits effective if:
 - Forecasted to be ratified in 2004
- EPA regulations
 - New category 1, 2 engines (1999)
 - New category 3 engines (2002)
 - NO_x, HC, CO, and PM
- CARB regulation
 - Ferries use hwy diesel by 2007
- Ozone Nonattainment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



Why a Program?

Growing Marine Emissions

Santa Barbara NOx Example



NOx Tons per Day

PROGRAM OVERVIEW

A decorative graphic element consisting of a blue gradient shape that starts as a thin line on the left and curves downwards and to the right, ending as a solid blue area at the bottom right corner of the slide.



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



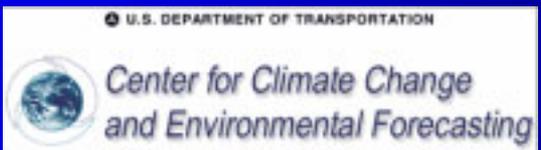
Overview - Program Plan



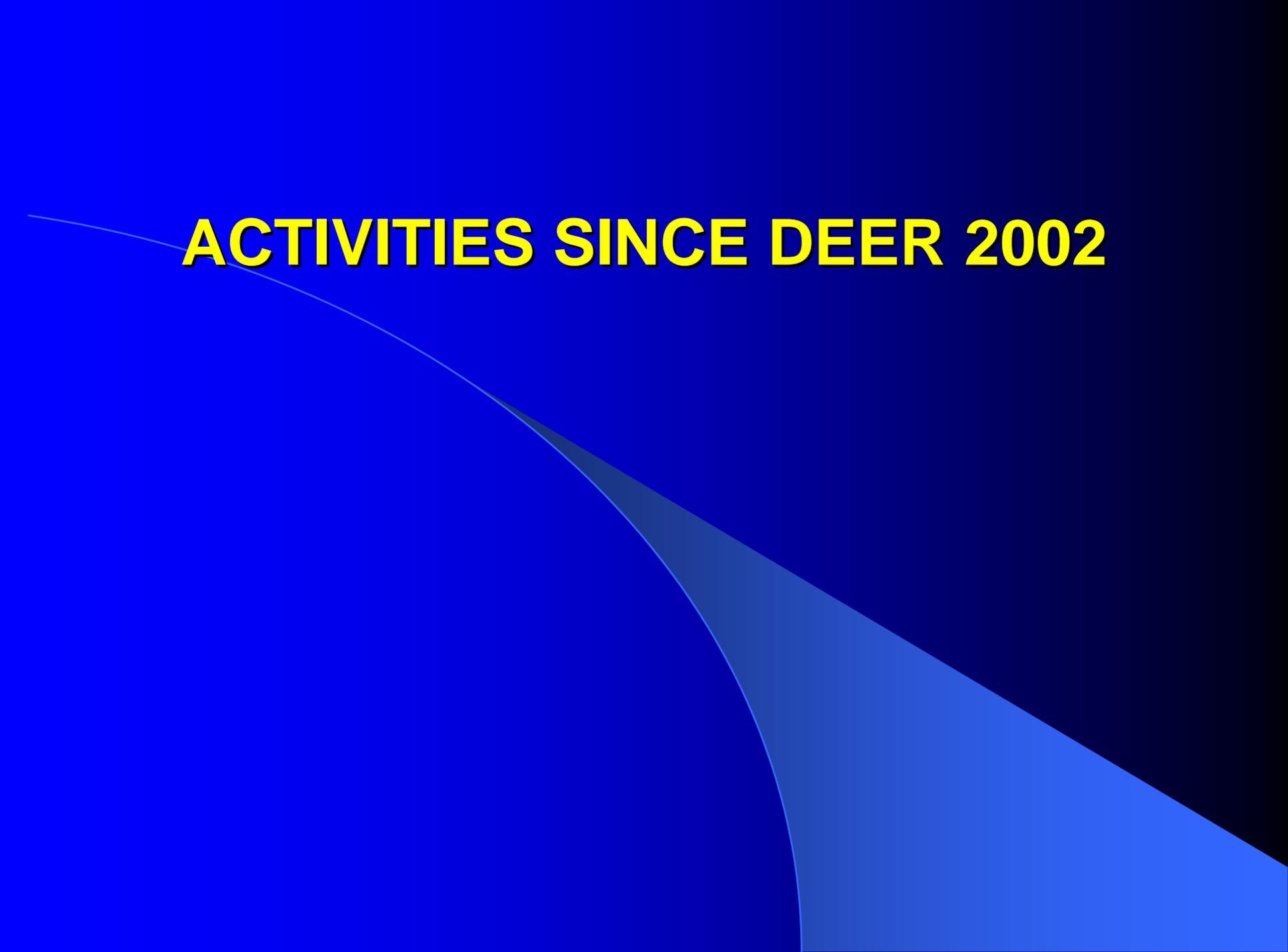
- **Baseline performance testing**
 - Existing vessel data and measurement techniques
- **Diesel retrofits**
 - Emulsified fuel, water injection, SCR, particulate traps
- **Alternative fuels**
 - Natural gas, biodiesel, hydrogen, synthetic diesel
- **Advanced technologies**
 - Fuel cells, high efficiency gas turbines
- **Supporting studies**
 - Technology evaluations, incentives and emission trading
- **Industry outreach**
 - Newsletter, conferences, website, and presentations



Overview - Partners



ACTIVITIES SINCE DEER 2002

The background is a solid dark blue. A light blue curved line starts from the left edge, curves downwards and to the right, and then continues as a straight line towards the bottom right corner. This line separates the top text area from the lower part of the slide.



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



SCX Ferry - MV WESTFOIL

Modified Hydrofoil Design

- 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

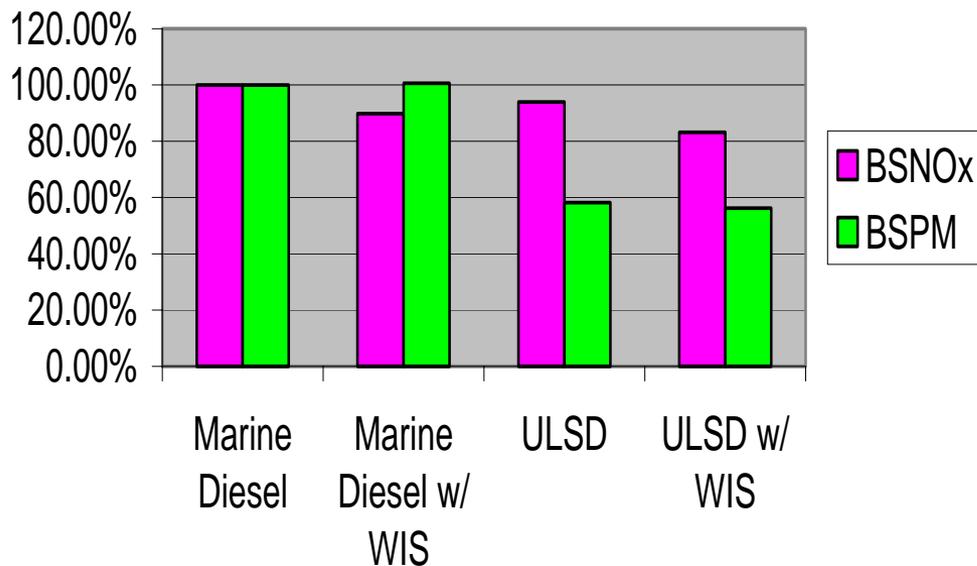


Activities - Ferry Retrofit #1

Test Results



Relative Brake Specific NO_x & PM
@ Cruising Speed



- Diesel sulfur samples
 - 4000 ppm baseline
 - 400 ppm ULSD (contam'?)
- Specific NO_x 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



Activities - Ferry Retrofit #2

Selective Catalytic Reduction & ULSD/Biodiesel Blend



Staten Island Ferry

- Seven SI ferries total
- Pilot on Austin Class vessel
 - (2) Cat 3516 Engines
- SCR for NO_x >70% reduction
- Offset NO_x - 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?

Test Originator	Location	Motivation
SCX Ferries	San Diego	State funding verification
Blue and Gold Lines	San Francisco	Public knowledge
Golden Gate Ferries	San Francisco	Public knowledge
POSCO Lines	San Francisco	Compliance demo
Hampton Roads Transit	Norfolk	Public knowledge
Carl Moyer Program	SCAQMD	Incentive verification
Port of LA *	Los Angeles	Emission Inventory
Staten Island Ferries*	New York	Compliance demo
NYSERDA*	New York	Public knowledge
CARB - Container Ships*	California	Public knowledge

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**

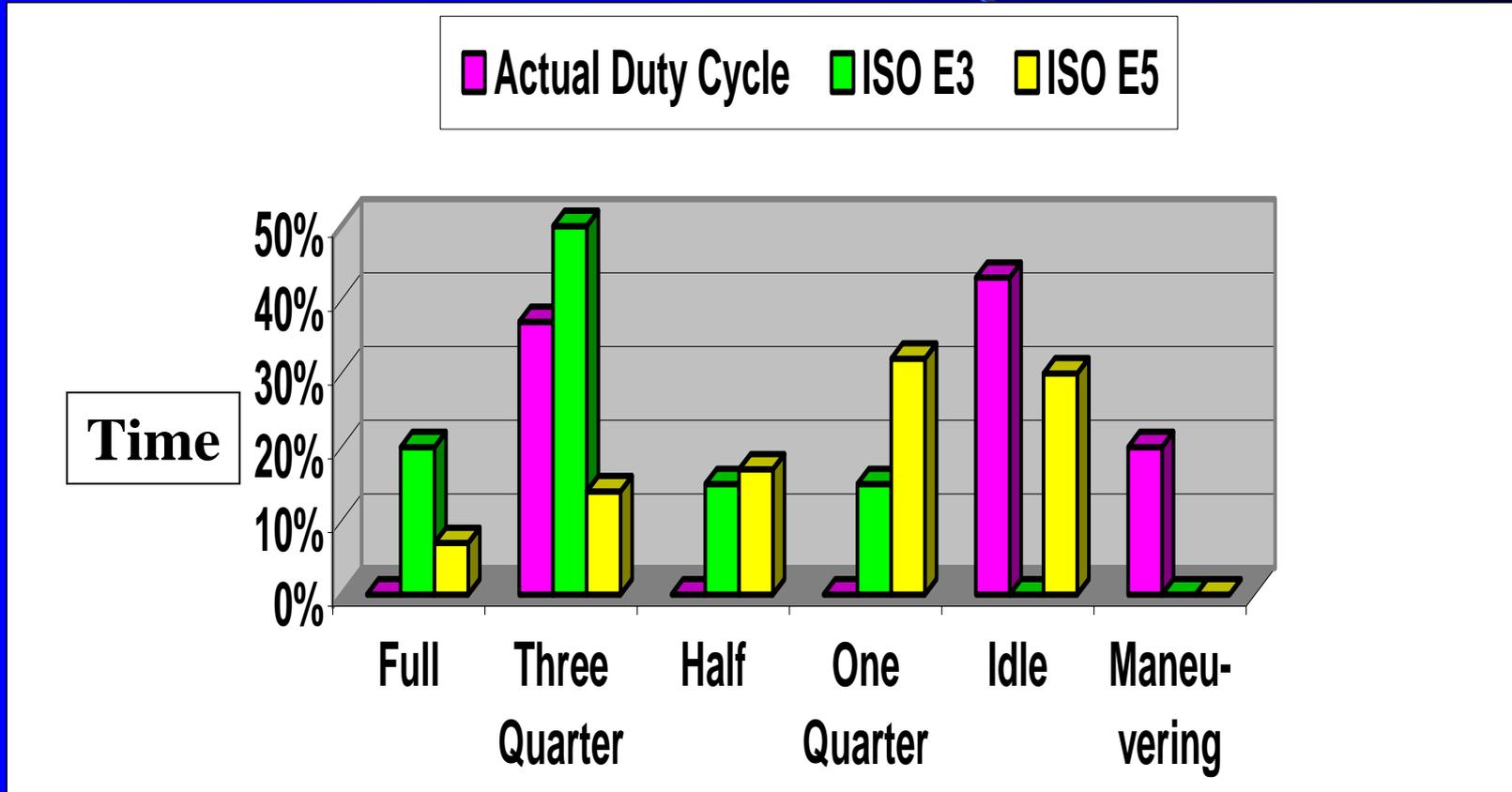
- **Safety**
 - **Calibration gases**



Activities - Studies



Measurement Protocols Duty Cycle Vs Lab Test Cycle



Throttle Setting



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



U.S. Department of Transportation
Maritime Administration
Office of Shipbuilding and Marine Technology



Energy Technologies

Newsletter No. 03 Spring 2003

- 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”
- For newsletter subscription:
 - Regina.Farr@marad.dot.gov
 - (202) 366-1924
- Re: Presentation or program
 - Daniel.Gore@MARAD.DOT.GOV
 - (202) 366-1886