Harbor Craft & OGVs

U.S. Experiences & Regulation of Marine Fuel & Other Emission Reduction Strategies & Incentives

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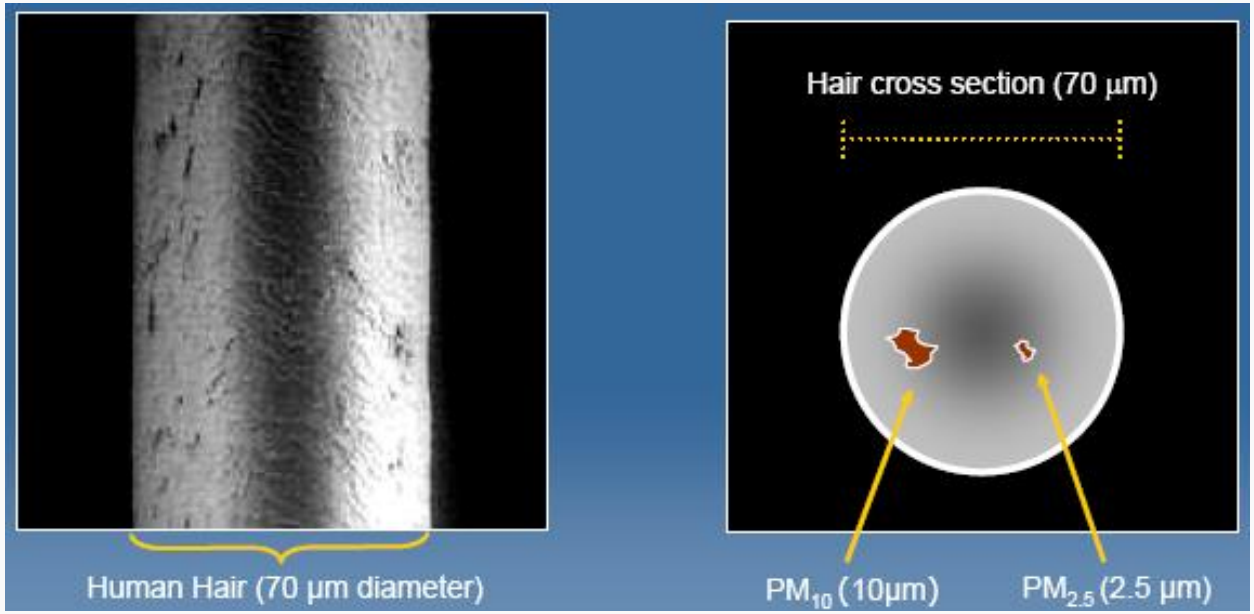
July 12, 2011

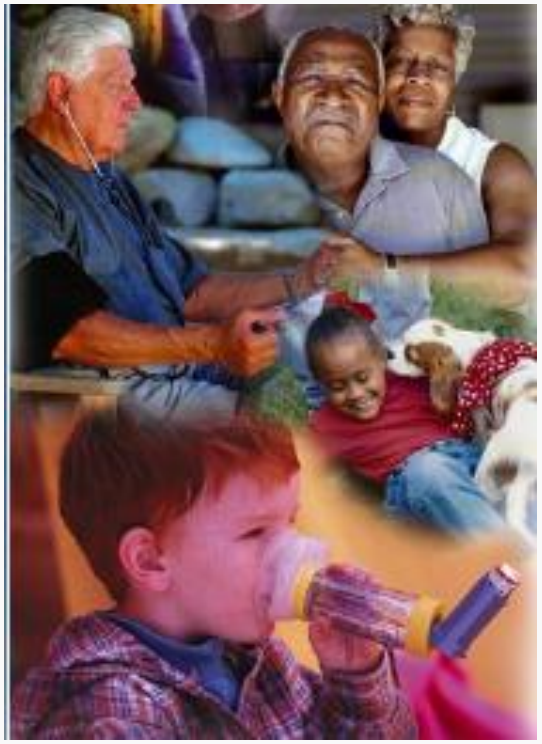
Hong Kong

Presentation Outline

- Introduction
- The impetus: protect human health & environment
- US EPA domestic regulation
  - Marine vessel regulations
- US government action with ECA
- State marine rules and regulations
- Marine vessel experiences
- Marine vessel incentives
- Roundtable discussion on barriers, opportunities, next steps

Protecting Human Health & the Environment





US EPA's Mobile Source Regulatory Roadmap

Tier 2 Light-Duty
final rule 1999
fully phased in 2009
Diesels held to same stringent standards as gasoline vehicles

Heavy-Duty Highway
sales 800,000 / yr
40B gallons / yr
final rule 2000
fully phased in 2010

Nonroad Diesel
sales over 650,000 / yr
12B gallons / yr
final rule 2004
fully phased in 2015

Locomotive/Marine
sales 40,000 marine engines,
1,000 locomotives / yr
6B gallons / yr
final rule 2008
fully phased in 2017

Ocean Going Vessels
CAA Rule Dec 2009
IMO MARPOL Annex VI
ECA Controls
- Fuel Based 2015
- SCR Catalyst Based 2016

Note: sales and diesel fuel usage vary year-to-year; these figures are for comparison purposes only

Federal & California Non-Road Diesel Fuel Standards

LSD & ULSD Implementation Schedule

Non-road Diesel Fuel Standards

Who	Covered Fuel	2006	2007	2008	2009	2010	2011	2012	2013	2014
Large Refiners & Importers	NON-ROAD	500+ ppm	500 ppm	500 ppm	500 ppm	15 ppm	15 ppm	15 ppm	15 ppm	15 ppm
Large Refiners & Importers	LOCOMOTIVE & MARINE	500+ ppm	500 ppm	500 ppm	500 ppm	500 ppm	500 ppm	15 ppm	15 ppm	15 ppm
Small Refiners & Other Exceptions	NON-ROAD, LOCOMOTIVE & MARINE	500+ ppm	500+ ppm	500+ ppm	500+ ppm	500 ppm	500 ppm	500 ppm	500 ppm	15 ppm

Except in California, compliance dates for Non-Road, Locomotive and Marine fuels in the years indicated are: June 1 for refiners and importers, August 1 downstream from refineries through fuel terminals, October 1 for retail outlets, and December 1 for in-use.

In California, all diesel fuel transitioned to ULSD in 2006. Locomotive and Marine diesel fuels were required to transition to 15 ppm ULSD effective January 1, 2007.

US EPA Marine Engine Regulations

- USEPA Marine Engine Regulations
  - 1999 Marine Engine Rule
  - 2002 Recreational Engine Rule
  - 2003 Category 3 Engine Rule
  - 2008 Category 1/2 Engine Rule
  - 2009 Category 3 Engine Rule

US EPA Marine Engine Regulations

1999 Marine Engine Rule

- On November 23, 1999, the EPA signed the final rule "Control of Emissions of Air Pollution from New CI Marine Engines at or above 37 kW"
- The adopted Tier 2 standards for Category 1 and 2 engines are based on the land-based standard for nonroad engines, while the largest Category 3 engines are expected to comply with IMO MARPOL Annex VI limits.

US EPA Marine Engine Regulations

2002 Recreational Engine Rule

- Diesel engines used in recreational vessels are covered in the “Emission Standards for New Nonroad Engines—Large Industrial Spark-ignition Engines, Recreational Marine Diesel Engines, and Recreational Vehicles” regulation, signed on September 13, 2002.
- Applies to marine diesel engines used in recreational boats, such as yachts and cruisers

US EPA Marine Engine Regulations

2003 Category 3 Engine Rule

- EPA to develop NOx emission limits for Category 3 engines. The final rule “Control of Emissions From New Marine Compression-Ignition Engines at or Above 30 Liters Per Cylinder” was signed by the EPA in January 2003
  - Establishes Tier 1 emission standards for marine engines virtually equivalent to the IMO MARPOL Annex VI limits.

US EPA Marine Engine Regulations

2008 Category 1/2 Engine Rule

- A regulation signed on March 14, 2008 introduced Tier 3 and Tier 4 emission standards for marine diesel engines. The Tier 4 emission standards have an emphasis on the use of emission aftertreatment technology.
- To enable catalytic aftertreatment methods, the EPA established a sulfur cap in marine fuels (as part of the nonroad Tier 4 rule).
  - Sulfur limit of 500 ppm became effective in June 2007,
  - Sulfur limit of 15 ppm becomes effective in June 2012

US EPA Marine Engine Regulations

2009 Category 3 Engine Rule

- On December 18, 2009, the EPA signed a new emission rule for Category 3 engines (published April 30, 2010), which introduced Tier 2 and Tier 3 standards in harmonization with the 2008 Amendments to IMO MARPOL Annex VI

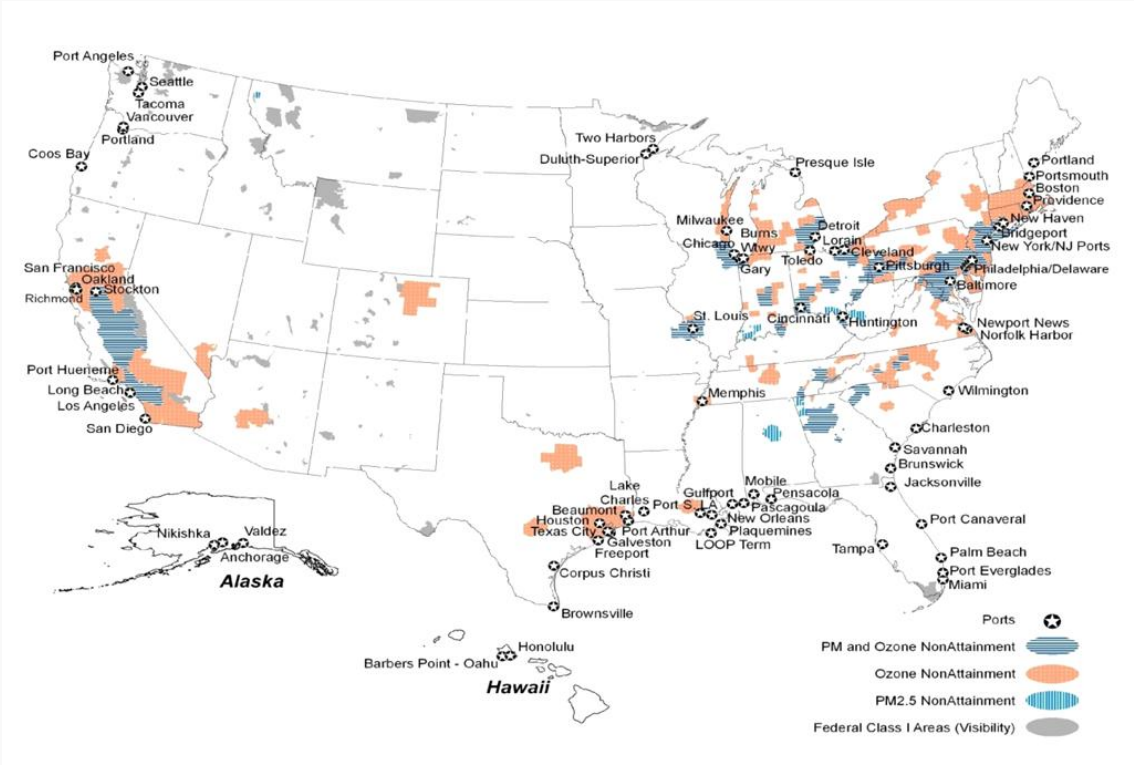
Emission Control Area (ECA)

International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL) – Annex VI (2008)

- Limits sulfur content of fuels and NOx emissions from ships traveling in Emissions Control Areas (ECAs)
- U.S./Canada/France Emission Control Area (ECA)
  - March 26, 2010 – Waters off North American coasts are designated as an ECA
    - 2012 – first phase of fuel standard
    - 2015 – second phase of fuel standard
    - 2016 – NOx aftertreatment requirements become applicable

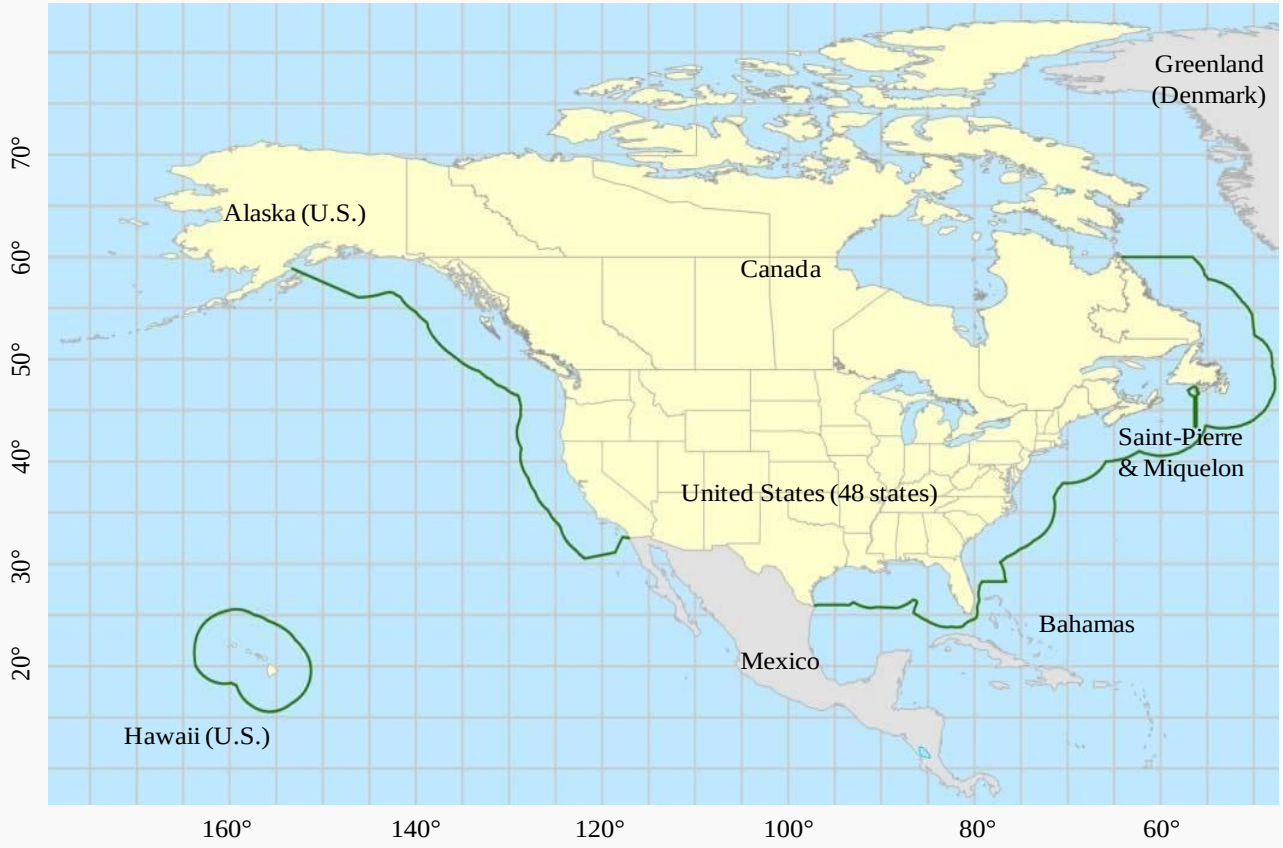
Sustainable ports must equate to healthy air: U.S. port and non-attainment areas

- More than 40 major ports are located in $PM_{2.5}$ or ozone nonattainment areas
- About 88 million people live in 39 areas that do not meet the $PM_{2.5}$ NAAQS or that contribute to violations in other counties

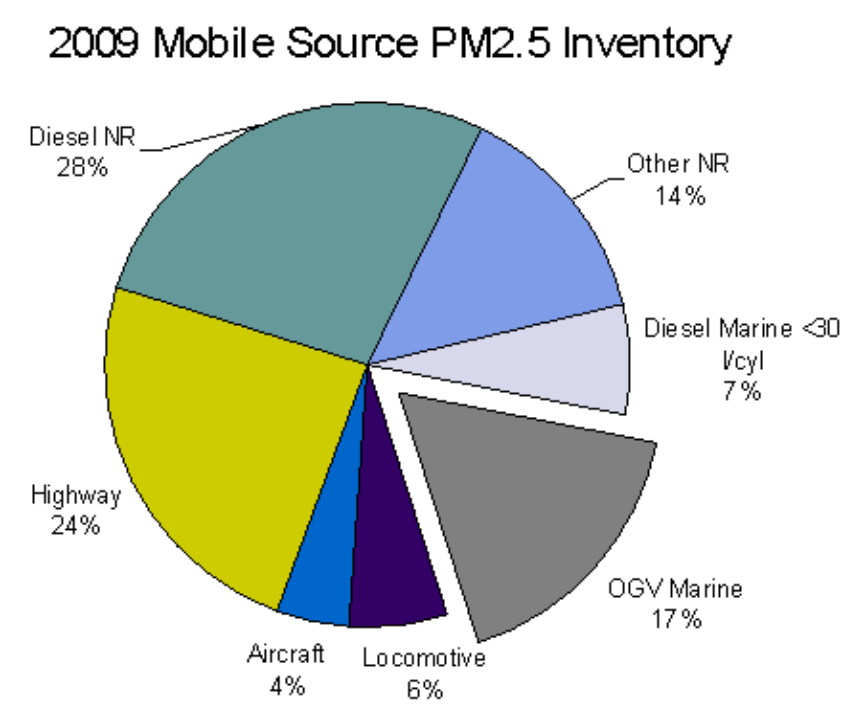


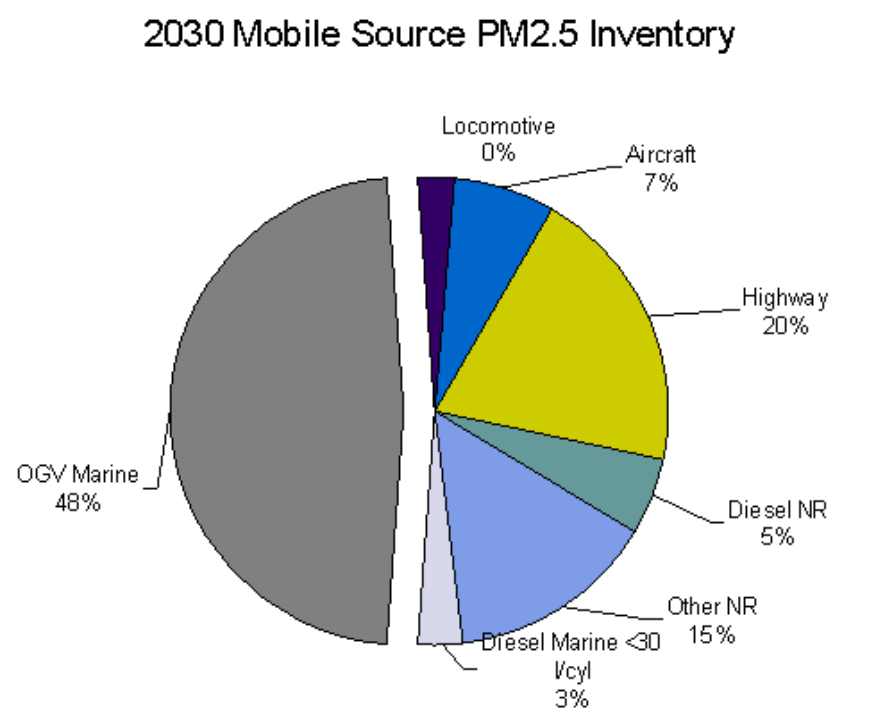
ECA Marine Fuel Switching Requirements

Area of U.S./Canada/France ECA - 200 nm from coasts of the U.S., Canada & French territories



Ship Contribution to U.S. PM2.5 Inventory



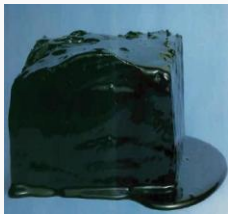


Source of inventory estimates: C3 Marine NPRM (July, 2009)
Does not reflect IMO MARPOL Annex VI Amendments (October 2008)

ECA Emission Controls

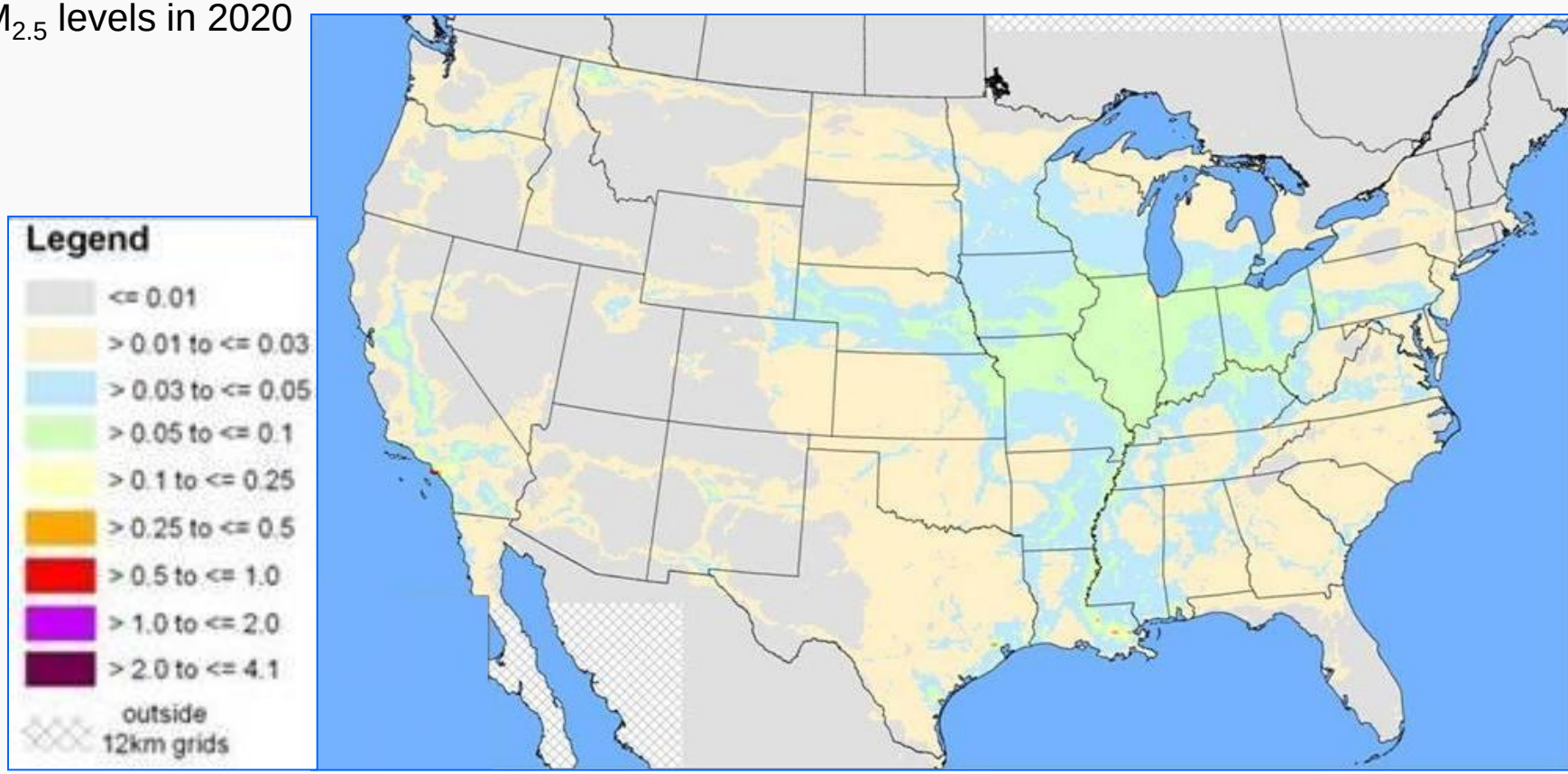
- ECA NOx controls
  - Tier 3 NOx: 80% reduction from new vessels (2016)
- ECA PM and SOx controls
  - 1.0% fuel sulfur (2010-2014)
  - 0.1% fuel sulfur (2015+)
    - Up to 96% reduction in SOx
    - ~85% reduction in PM

- MARPOL Annex VI (2008) Global NOx Controls
  - Tier 2 NOx: 20% reduction from new vessels (beginning in 2011)
  - Existing engine standards
- Global PM and SOx controls
  - 2012: 3.5% fuel sulfur
  - 2020: 0.5% fuel sulfur



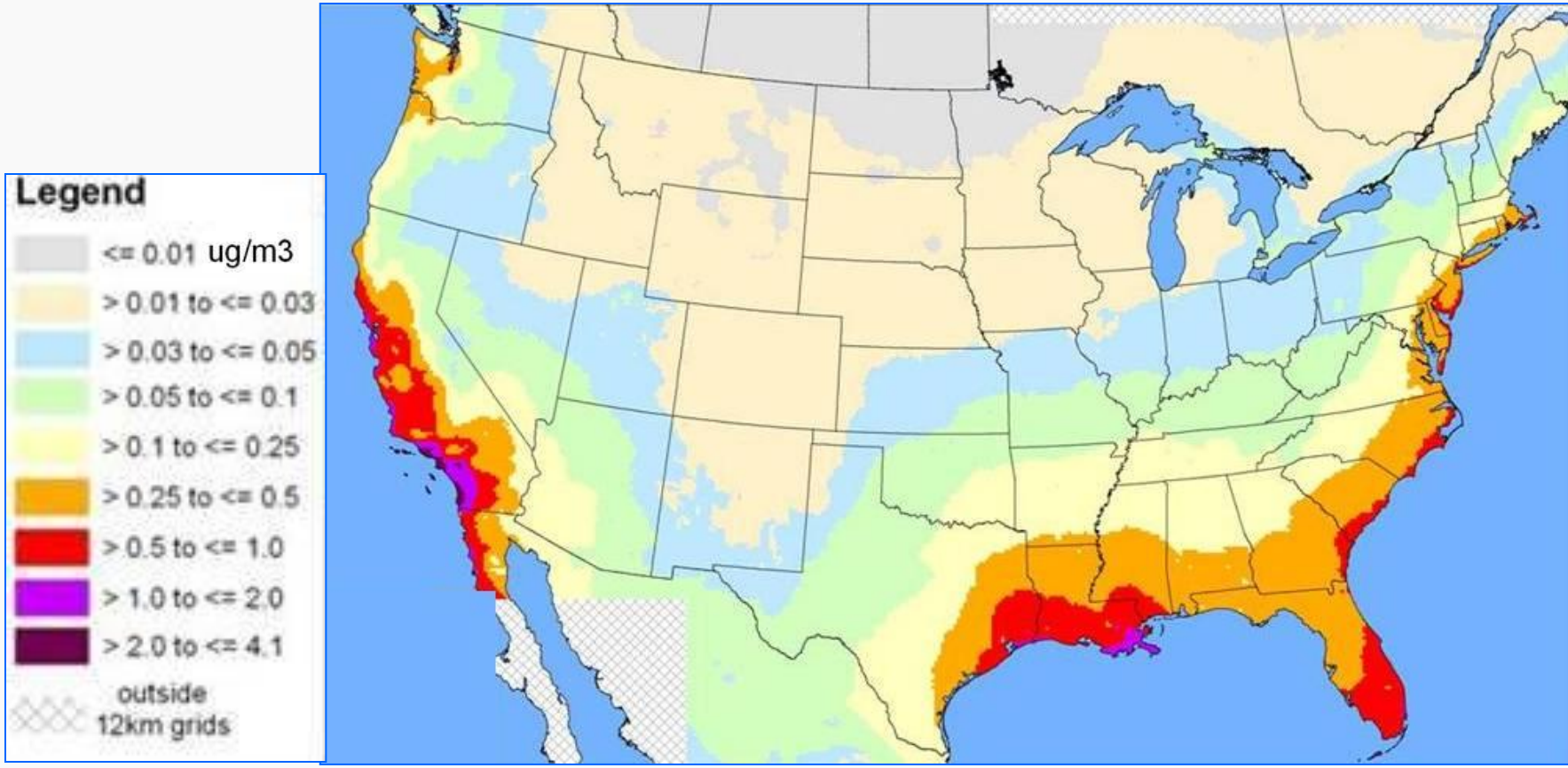
US EPA's 2008 Locomotive & Marine Diesel Engine Rule

For Comparison: Impact of EPA's 2008 Locomotive & Marine Diesel Engine Rule on $PM_{2.5}$ levels in 2020



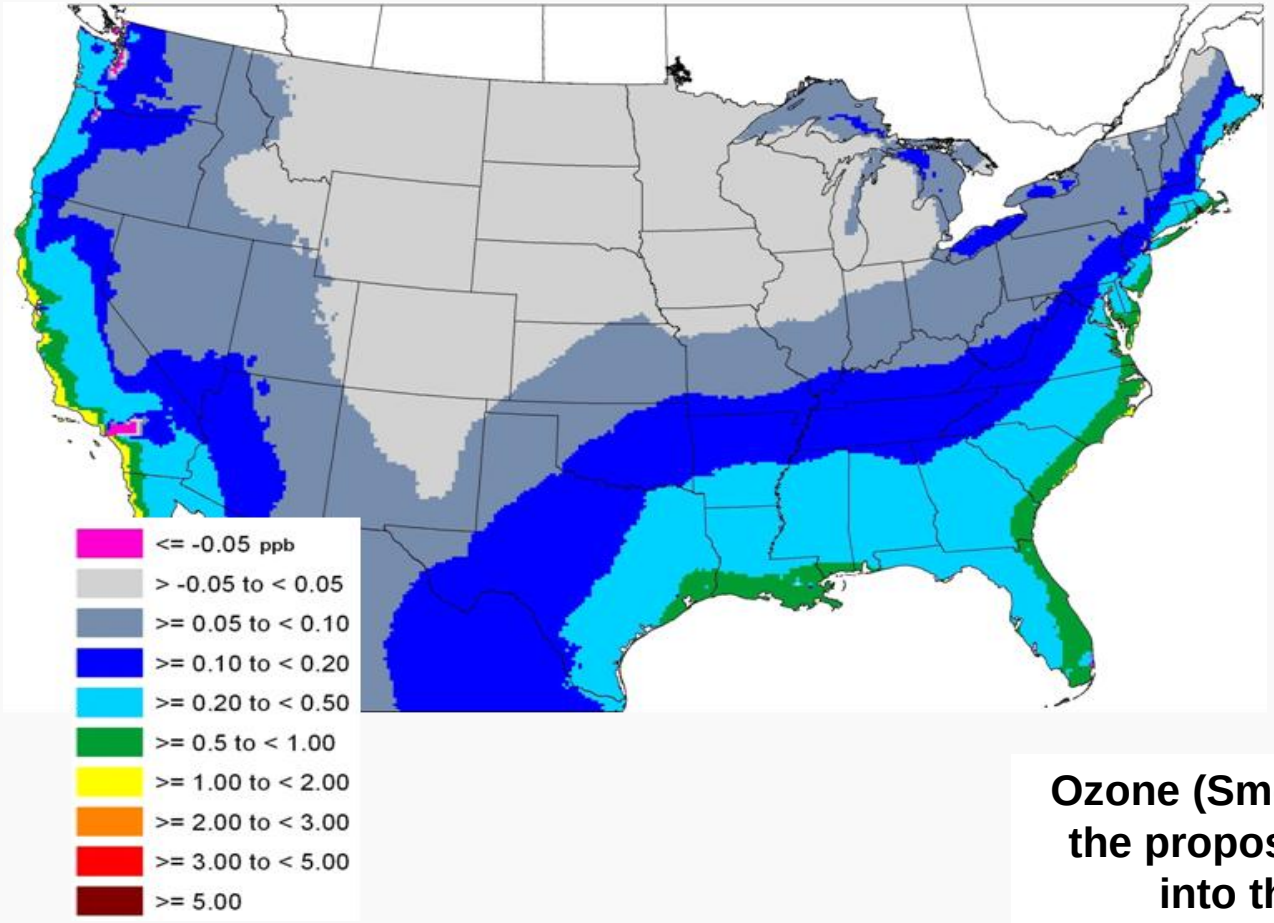
ECA Air Quality Improvements

2020 Potential ECA $PM_{2.5}$ Reductions



ECA Air Quality Improvements

2020 Potential ECA Ozone Reductions

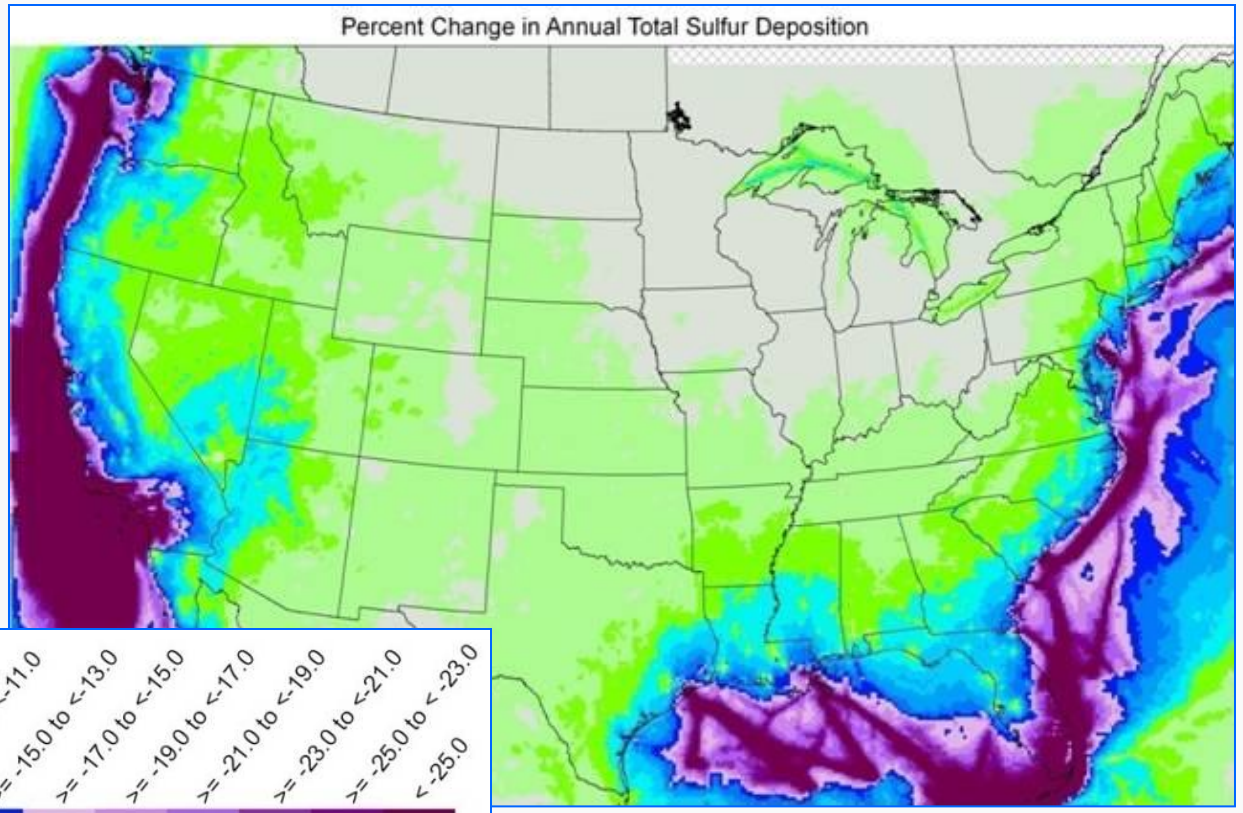


Ozone (Smog) reductions from the proposed ECA reach well into the U.S. interior

ECA Air Quality Improvements

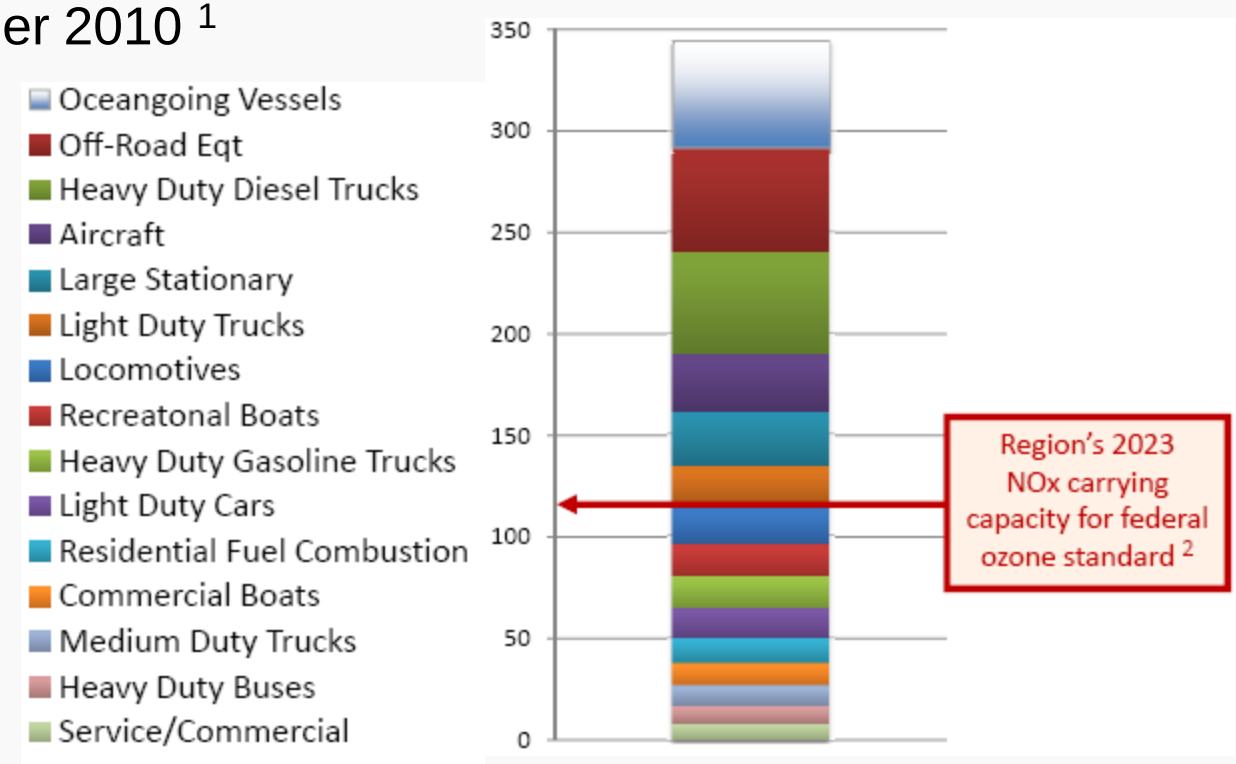
2020 Potential Sulfur Deposition Reductions

Improvements in deposition for marine and terrestrial ecosystems



Air Quality in the South Coast Air Basin

Top 15 NOx categories: 2023 NOx emissions with rules adopted through December 2010 [1]



1 Preliminary emissions estimates (tons per day) based on data updated from 2007 AQMP where available: CARB 2010 emissions projections for trucks and off-road equipment; IMO Tier 1 – 3 for ocean vessels; EPA 2008 rule for locomotives; 2007 AQMP short-term measures for other categories. Range for oceangoing vessels (20 -52) based on varying deployment assumptions for IMO Tier 2 and 3 vessels and range of ports' cargo forecasts.

Benefits & Costs

- In 2030 the estimated benefits are between $110 and $280 billion

- By 2030, the emission reductions associated with the coordinated strategy will annually prevent:
  - Between 13,000 and 32,000 PM-related premature deaths
  - Between 220 and 980 ozone-related premature deaths
  - About 1,500,000 work days lost
  - About 10,000,000 minor restricted-activity days

- The estimated costs are much smaller: $3.1 billion

California Marine Rules & Regulations

- CARB At-Berth Ocean-Going Vessels Regulation
- Harbor Craft Regulation
- OGV Vessel Fuel Switching
- OGV Vessel Speed Reduction (not final)

CARB At-Berth Ocean-Going Vessels Regulation

- Phased-in 2010 – 2020
- California Ports of Los Angeles, Long Beach, Oakland, San Diego, San Francisco, and Hueneme
- Requires vessel fleet operators visiting these ports to reduce at-berth emissions from auxiliary engines in one of two ways:
  - 1) turn off auxiliary engines for most of a vessel's stay in port and connect the vessel to some other source of power, most likely grid-based shore power; or
  - 2) use alternative control technique(s) that achieve equivalent emission reductions.

CARB Harbor Craft Regulation

- Effective Jan. 1, 2009
- Applies to all new & in-use commercial harbor craft vessels (ex) ferries, excursion vessels, tugboats, towboats, crew & supply vessels work boats, pilot vessels, & commercial & charter fishing boats operating in the Regulated Waters of California
- ~4,200 harbor craft vessels, & ~8,300 diesel engines on these vessels, use in California

CARB Harbor Craft Regulation

- Requires
  - Record keeping for each vessel
  - Installation of a non-resettable hour meter on each engine
  - Submittal of initial report to CARB & central record keeping for inspection
  - Repowers for certain vessels
- Why this rule is needed
  - California commercial harbor craft emit an estimated 3.3 tons per day (tpd) of diesel PM and 73 tpd of NOx

California Ultra Low Sulfur Fuel Use

- Since January 2007, all onroad & nonroad engines are required to use ULSD (15ppm sulfur) in California, including harbor craft

- No reported technical issues for harbor craft

Cost & Benefits

- Total cost of regulatory compliance ~$140 million over the life of the regulation
- Cost-effectiveness ~$29/lb PM reduced, if all costs are attributed to reducing diesel PM
- If costs are split evenly between reducing PM and NOx - cost-effectiveness ~$14/lb PM and ~$1,800/ton NOx
- Health cost savings ~$1.3 billion to $2 billion

Northwest Ports Harbor Craft

- Beginning in 2008 - Harbor craft voluntarily use ULSD

- No technical issues reported

New York/New Jersey Port Harbor Craft

- 2002 began voluntary private ferry clean diesel program – tested ULSD in ferries
- Implementing engine retrofit and replacement program
- No issues reported

- Note: 2011 Began voluntary OGV fuel switching program

California OGV Vessel Fuel Rule

- Effective July 2009
- Requires OGV's to switch to low sulfur diesel 0.5% to 1.5% at 24 nm off the California coast
- By 2012 harmonize with ECA to require 0.1% sulfur fuel

California OGV Operational Experiences with Vessel Fuel Switching

- Examined Three Sources of Information
  - CARB Ocean-Going Vessel Operational Experience Survey (2009)
  - U.S. Coast Guard fuel switching-related loss of propulsion incidents (LOPs)
  - Pilot reports
    - Long Beach Pilots
    - SF Bar Pilots

CARB Ocean-Going Vessel Operational Experience Survey (2009)

- Designed to collect information on operational experience with the use of low sulfur distillate fuels in response to OGV Clean Fuel Rule
- Sent to CARB listserv (2,400 members)
- Survey included two parts
  - Survey ship operators
  - Survey fleet manager

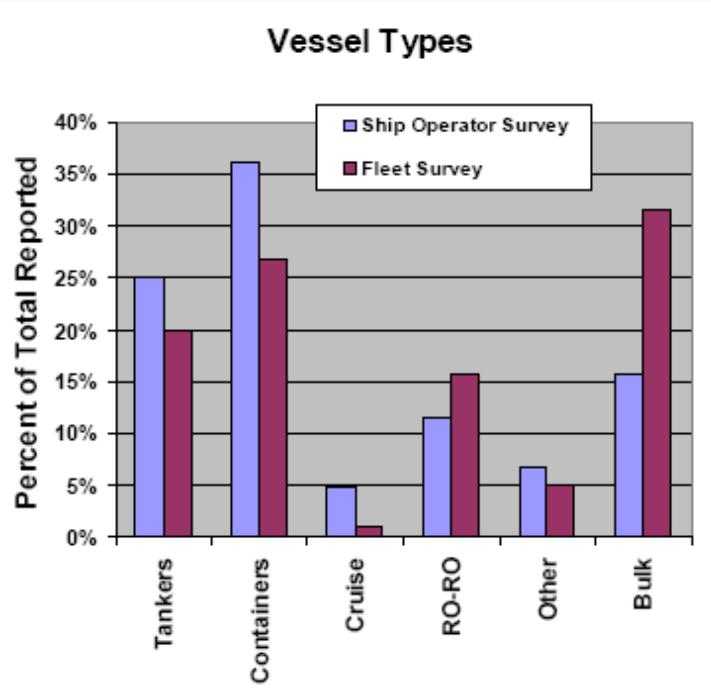
CARB Ocean-Going Vessel Operational Experience Survey (2009)

- Categorized into five areas to indentify main areas of concern
  - operational changes made in response to rule
  - transiting or maneuvering issues
  - main engine start issues
  - equipment issues
  - fuel properties comments

CARB Ocean-Going Vessel Operational Experience Survey (2009)

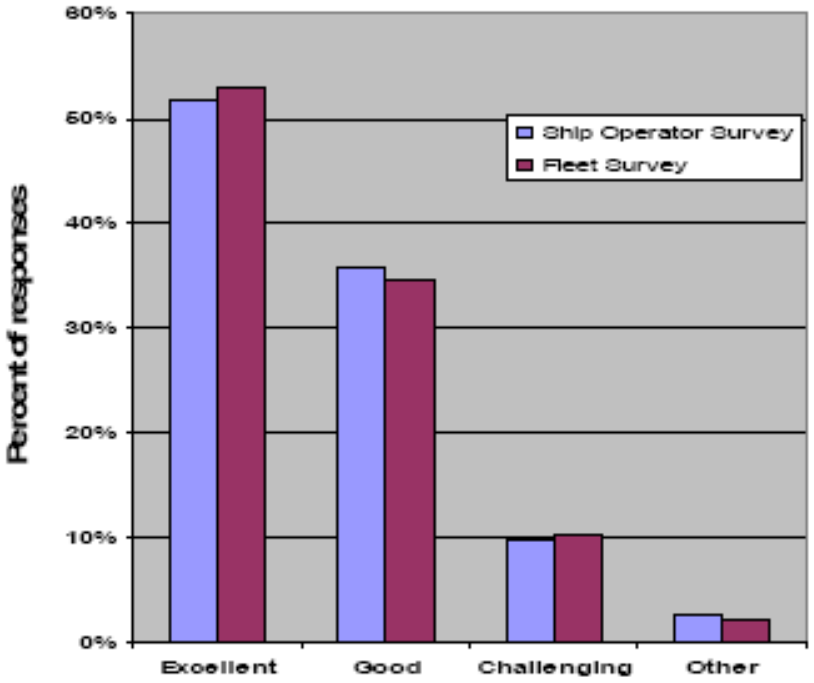
Number of survey participants

- Ship operator responses
  - reported information on 148 vessels
- Fleet operator responses
  - representing 1723 vessels



CARB Ocean-Going Vessel Operational Experience Survey (2009)

Experiences with the use of low sulfur fuel since implementation of rule*



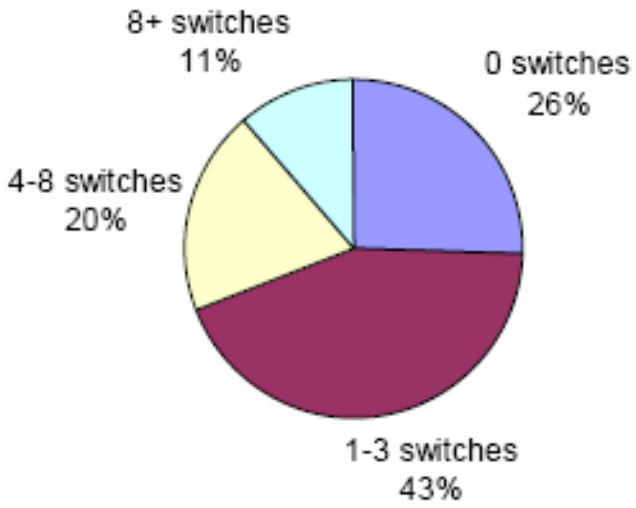
	Ship Operator Survey		Fleet Survey	
Excellent	58	51.8%	26	53.1%
Good	40	35.7%	17	34.7%
Challenging	11	9.8%	5	10.2%
Other	3	2.7%	1	2.0%
Total Responses	112		49	

*Based on 112 responses to the operator survey and 49 responses to the fleet survey

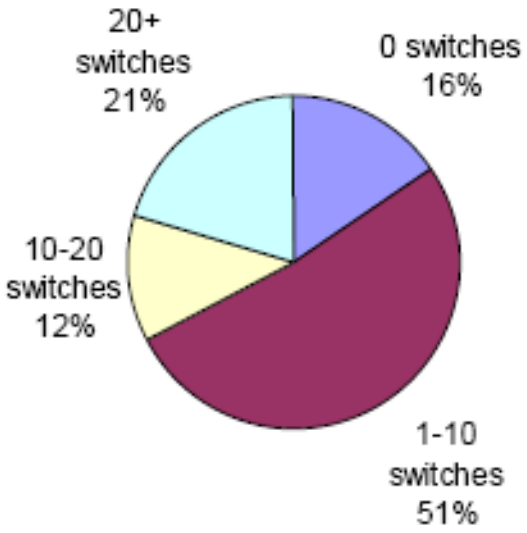
CARB Ocean-Going Vessel Operational Experience Survey (2009)

Number of fuel switches*

Ship Operator Survey (number of times the vessel has fue switched)



Fleet Survey (number of times the fleet has fuel switched)



*As of date of survey (November, 2009)

CARB Ocean-Going Vessel Operational Experience Survey (2009)

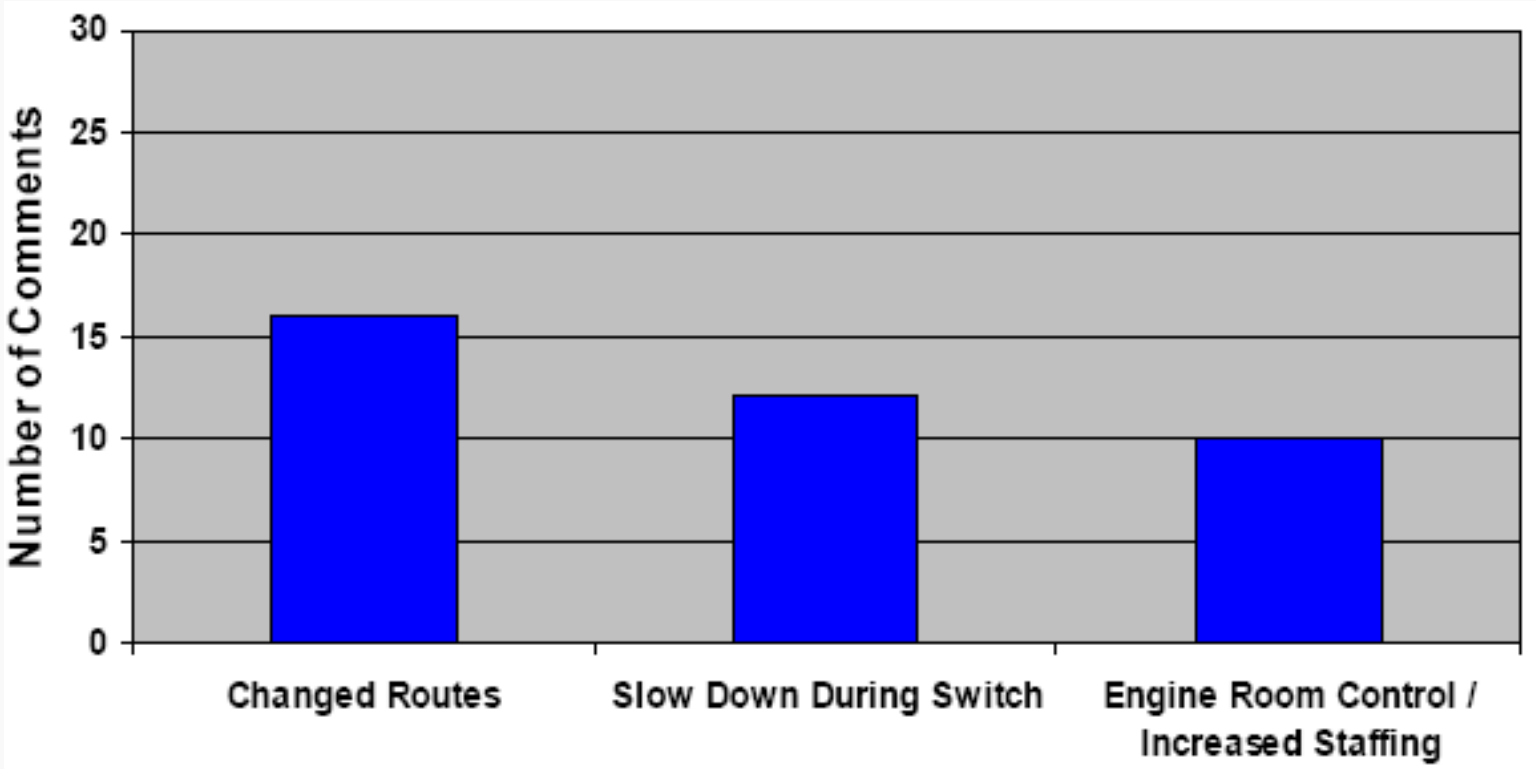
Summary of responses to survey questions

	Ship Operator Survey		Fleet Survey	
	Yes Responses	Percent	Yes Responses	Fleet survey
Did you test your vessels on distillate prior to CA visit?	57	39%	21	36%
Have you made equipment changes to operate on distillate?	7	5%	4	7%
Do you have on board fuel switching procedures for crew members?	105	71%	36	62%
Have you had to modify the fuel switching procedures based on in-use experience?	12	8%	5	9%
Do you have documented training procedures for fuel switching?	85	57%	37	64%
Problems finding fuel?	10	7%	3	5%
Have you made operational changes due to fuel switching?	36	24%	9	16%

*Positive responses reported. Percentage based on total number of records (148 operator records, 58 fleet manager records)

CARB Ocean-Going Vessel Operational Experience Survey (2009)

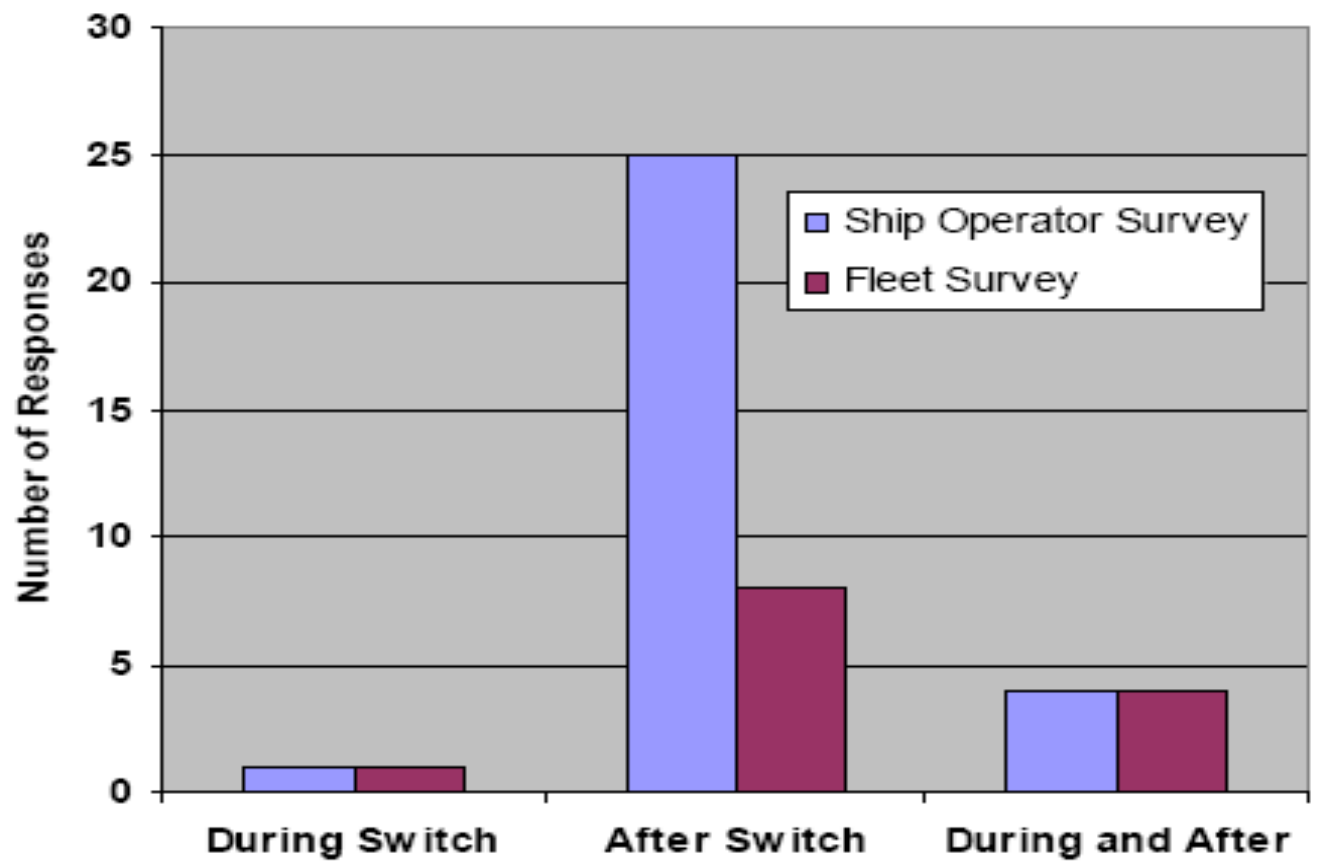
Types of operational changes made due to fuel switching



*This information was compiled by categorizing the survey comment fields

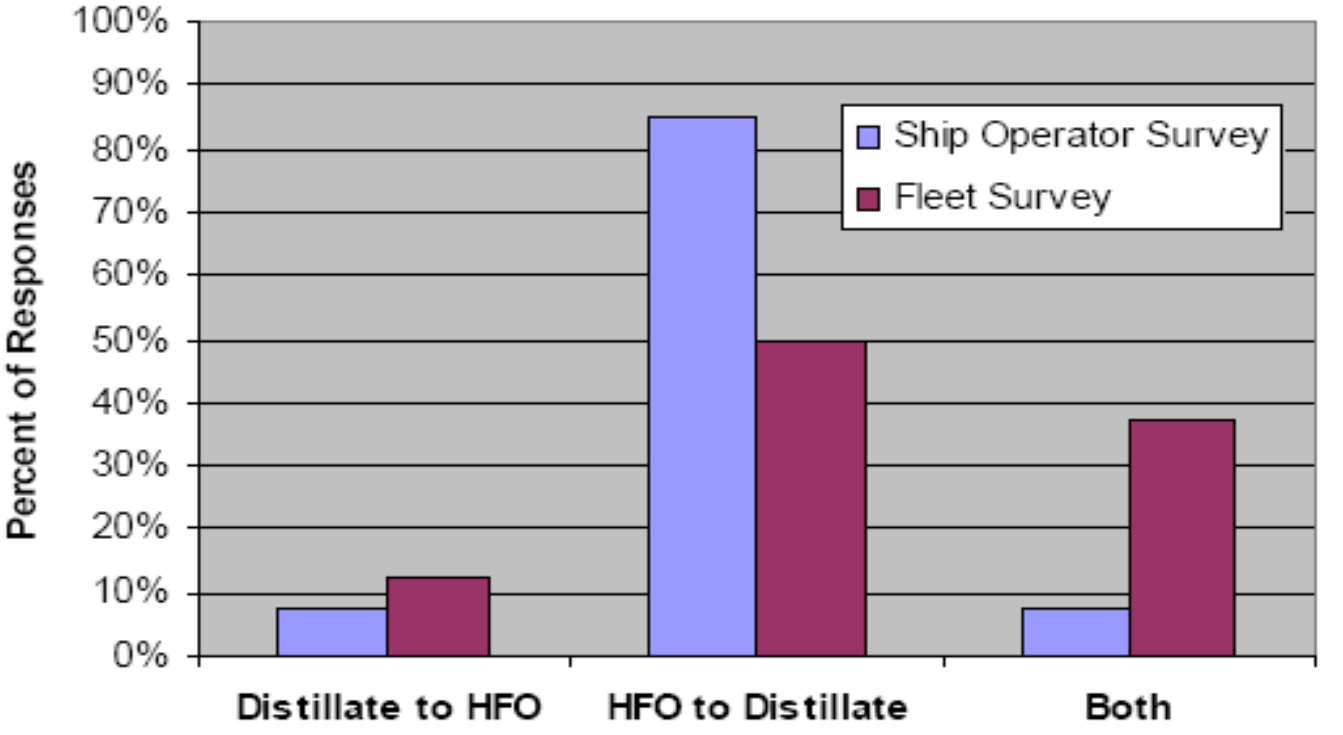
CARB Ocean-Going Vessel Operational Experience Survey (2009)

Q: If you had any problems, did the problem occur during fuel switching, after fuel switching or both?



CARB Ocean-Going Vessel Operational Experience Survey (2009)

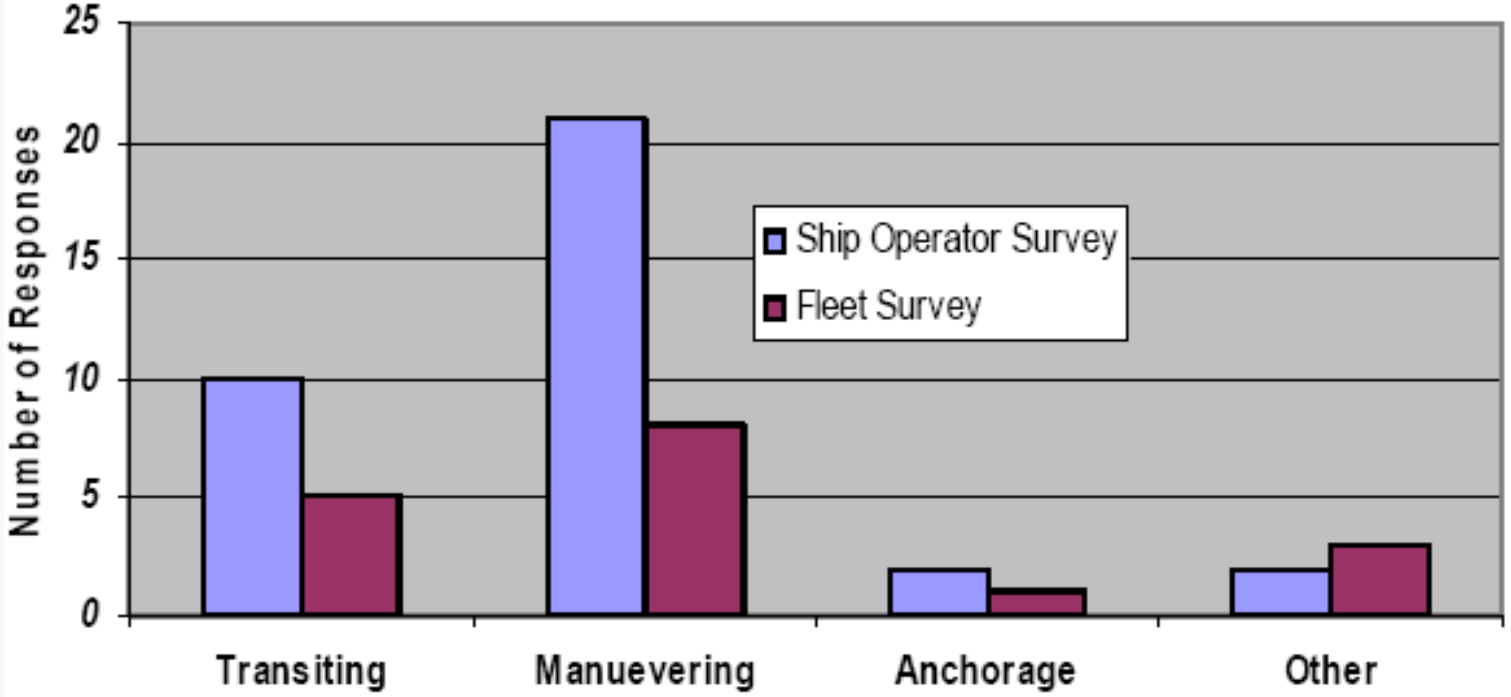
Q: If you had problems, did the problem occur from the fuel switching: Distillate to HFO; HFO to Distillate or both?



*Based on 27 operator responses and 8 fleet responses

CARB Ocean-Going Vessel Operational Experience Survey (2009)

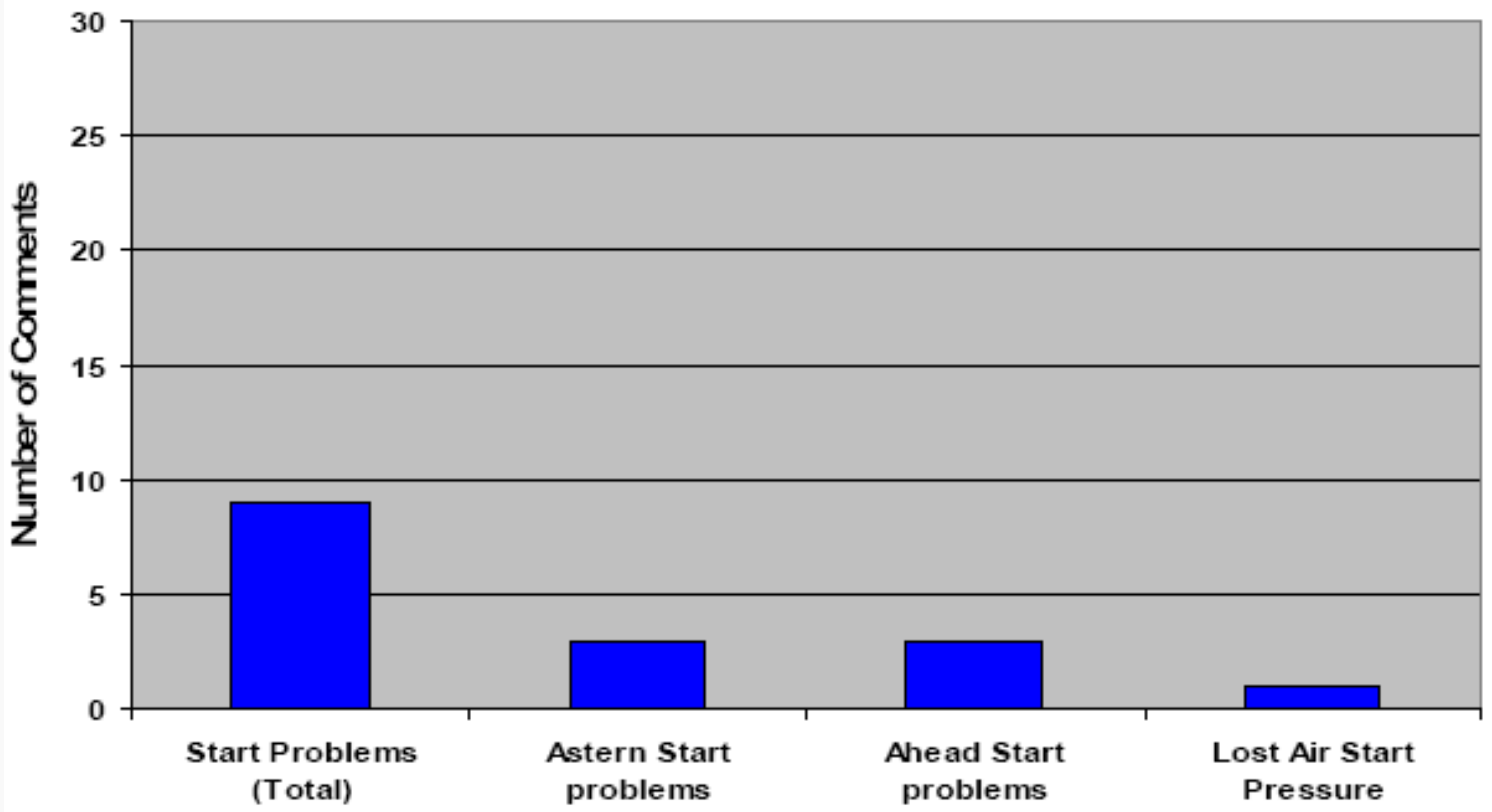
Q: If you had problems, did the problem occur during transiting, maneuvering, anchoring or other?



*Some operators reported for more than one category

CARB Ocean-Going Vessel Operational Experience Survey (2009)

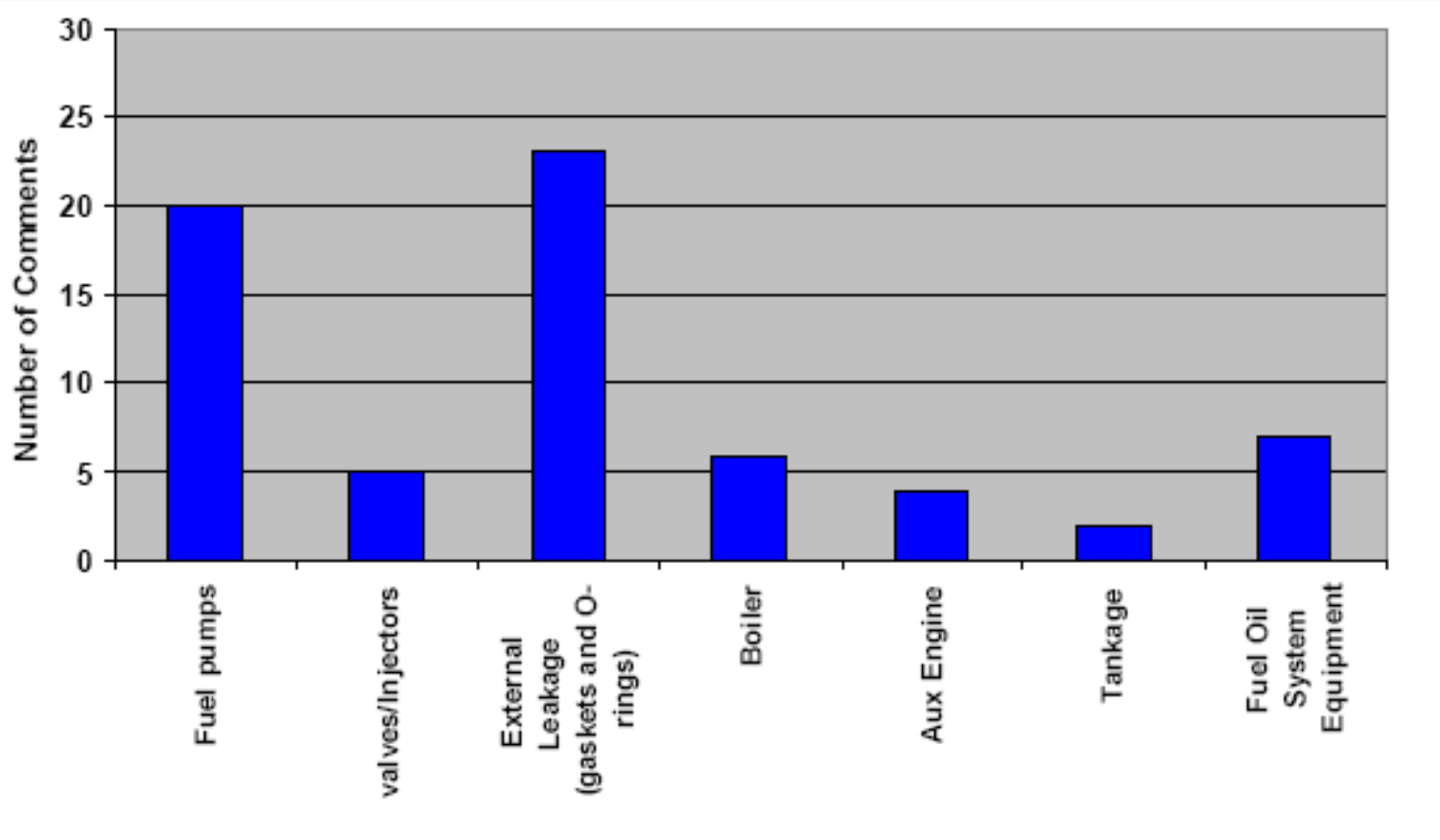
Reported main engine start problems*



*This information was compiled by categorizing the survey comment fields

CARB Ocean-Going Vessel Operational Experience Survey (2009)

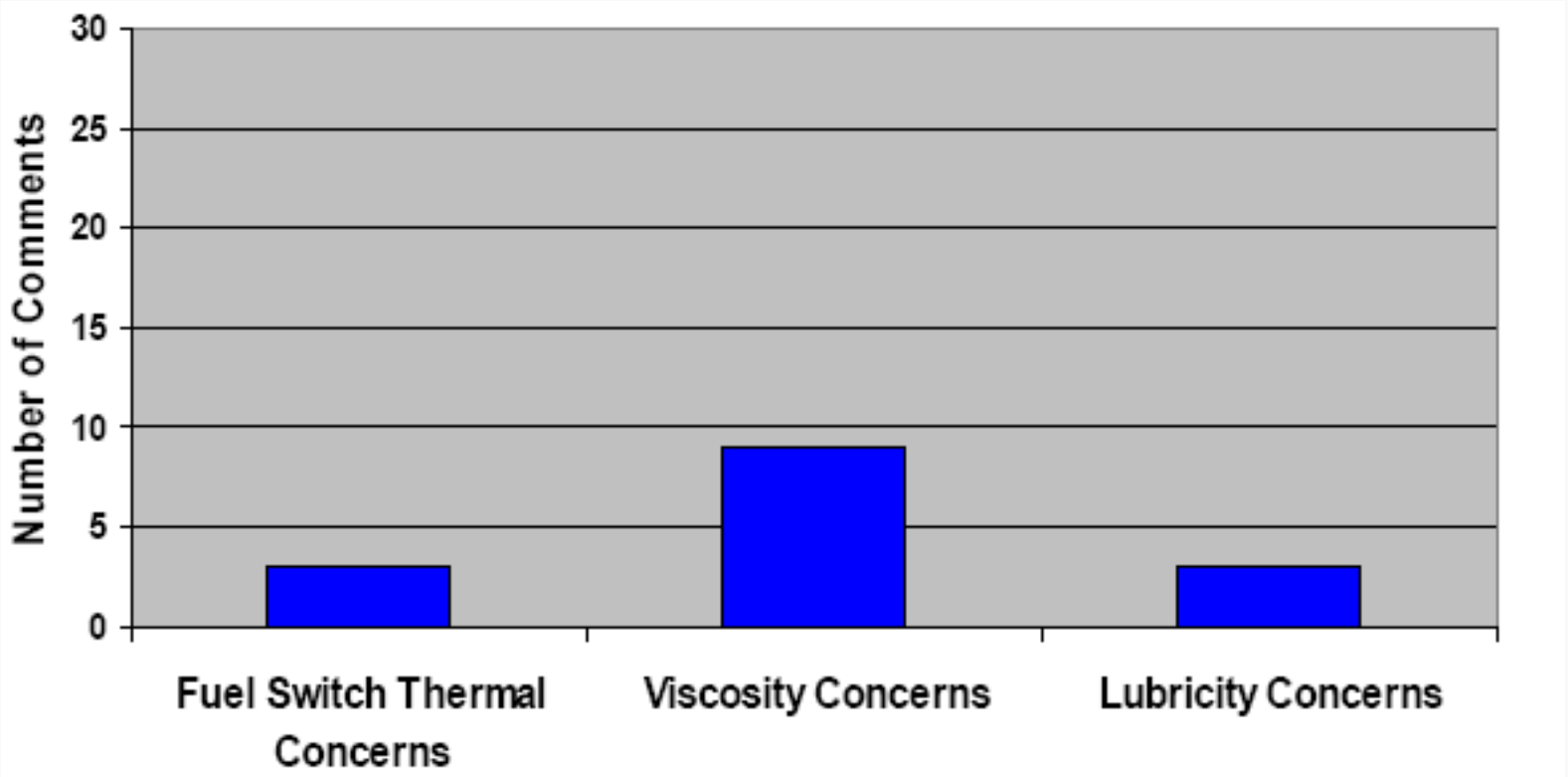
Equipment problems reported*



*This information was compiled by categorizing the survey comment fields

CARB Ocean-Going Vessel Operational Experience Survey (2009)

Fuel Property Concerns*



*This information was compiled by categorizing the survey comment fields

CARB Ocean-Going Vessel Operational Experience Survey (2009)

OGV Survey Summary

- 85 percent of operators that had fuel switched had excellent or good experience
- Some operators have reported operational changes
  - changing routes
  - slowing down during switch
  - increased staffing/engine room control
- Most operators reported that the fuel was available

CARB Ocean-Going Vessel Operational Experience Survey (2009)

OGV Survey Summary (continued)

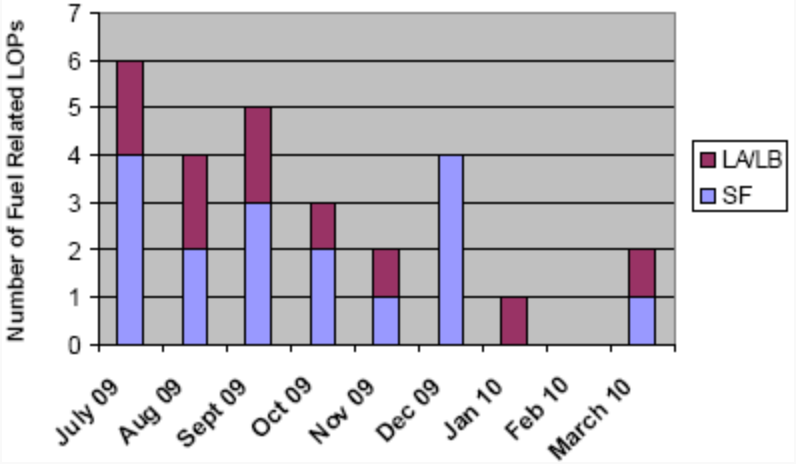
- Fuel switching related problems were primarily noted for the following
  - after switching from HFO to distillate
  - equipment problems
    - fuel pumps
    - leakage (o-rings and gaskets)
  - maneuvering operations
    - higher number of problems reported during maneuvering compared to transiting

CARB Ocean-Going Vessel Operational Experience Survey (2009)

OGV Survey Summary (continued)

- Fuel switching related problems were primarily noted for the following (continued)
  - fuel properties
    - higher number of comments were for viscosity concerns

U.S. Coast Guard fuel switching-related loss of propulsion incidents (LOPs) in California



# LOPs*	July-09	Aug-09	Sept-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	March-10	July 09-March 10
SF	4	2	3	2	1	4	0	0	1	17
LA/LB	2	2	2	1	1	0	1	0	1	10
Total	6	4	5	3	2	4	1	0	2	27

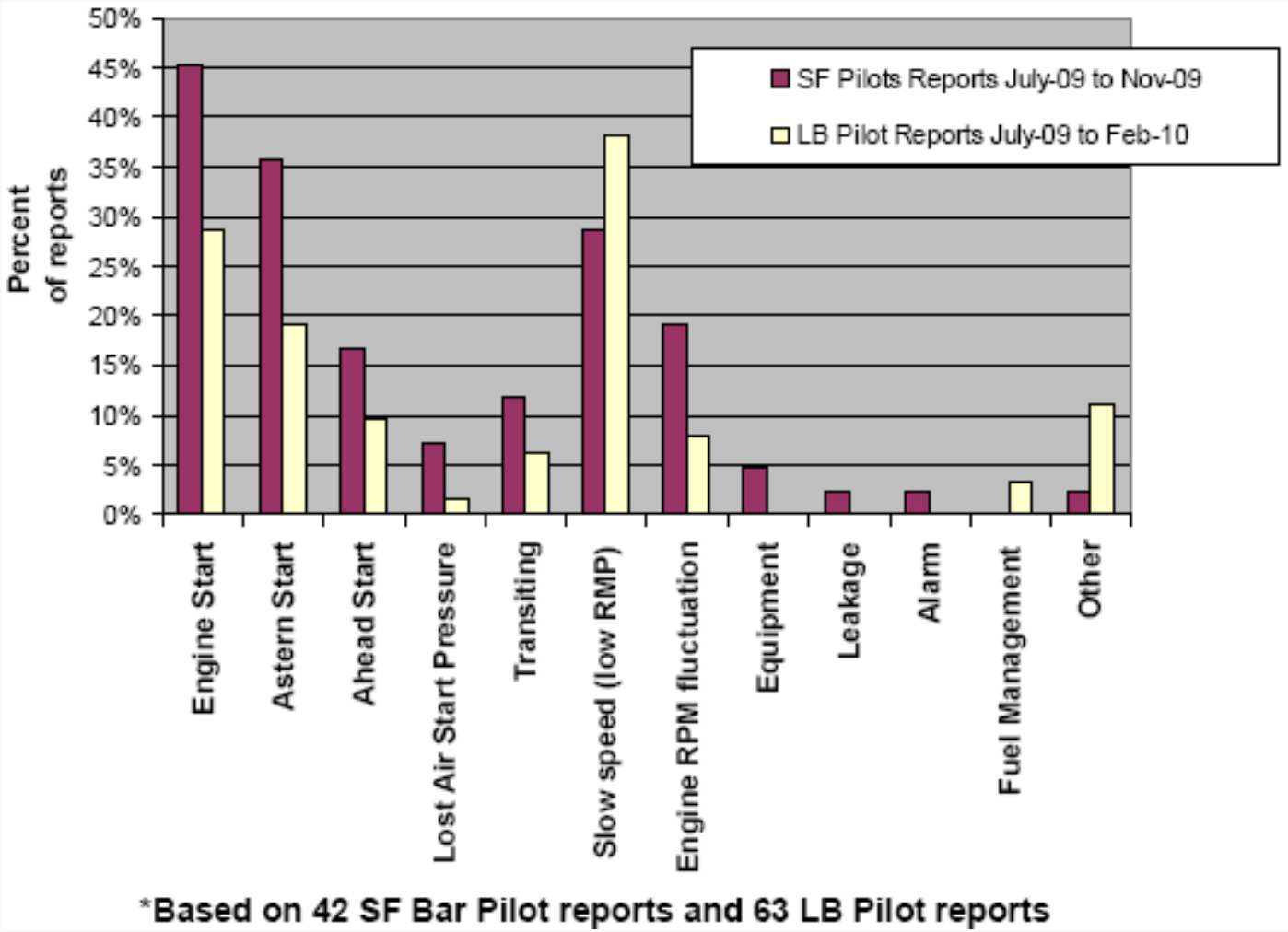
* (U.S. Coast Guard D11, LOPs where operation on distillate fuel was a causal factor. July 1, 2009 through March 31, 2010)

U.S. Coast Guard fuel switching-related loss of propulsion incidents (LOPs) in California - Summary

- Number of distillate fuel related LOPs* per month has decreased as regulation is in place longer
- Many fuel related LOPs* had failure to start issues
  - higher number of start issues in SF Bay region, dominated by astern starts problems
- More fuel related LOPs* occurred during maneuvering than transiting
- Low fuel pressure, possibly related to the condition of fuel pumps or fuel viscosity, were noted in 9 of the fuel related LOPs*

*** (U.S. Coast Guard, LOPs where operation on distillate fuel was a causal factor. July 1, 2009 through March 31, 2010)**

Pilot Reports



*Based on 42 SF Bar Pilot reports and 63 LB Pilot reports

Pilot Reports - Summary

- Majority of SF Bar Pilots reports
  - main engine start problems
    - majority of the start problems were astern starts
  - problems operating at low speed/low RPM
- Majority of LB Pilots reports
  - problems operating at low speed/low RPM
  - included some main engine start problems

California OGV Operational Experiences Overall Summary

- With about 7,000 successful vessel visits, a small percentage of ships experience operational problems (~0.5%)
- Fuel related LOPs are decreasing as rule is in place longer
- Data collected provides useful insights into operational experiences in using cleaner distillate fuel for future OGV adoption under the ECA

Voluntary & Incentive Programs for Harbor Craft & OGVs

- Clean Ports USA Program
- Exploring a Voluntary Marine Verification Program for existing vessels
- Diesel Emission Reduction Act
- State, Local & Port-specific incentives

Thank you