

2nd Public Workshop to Discuss Development of Regulations for Ocean-going Ship Main Engines



June 13, 2007
Sacramento, CA



Overview

- ◆ Background
- ◆ Update on Ship Auxiliary Engine Regulation
- ◆ ARB Perspective on U.S. EPA and IMO Efforts to Reduce Ship Emissions
- ◆ Ship Survey Status
- ◆ Draft Regulatory Language
- ◆ Preliminary Estimates of Emissions Reductions
- ◆ Implementation Considerations
- ◆ Next Steps

Background



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Air Pollution is a Serious Public Health Concern

- ◆ Diesel PM identified as a Toxic Air Contaminant (1998)
- ◆ Non-Cancer Health Impacts of Diesel PM, SO_x, Ozone
 - Premature death
 - Respiratory disease
 - Cardiovascular disease
 - Activity restriction



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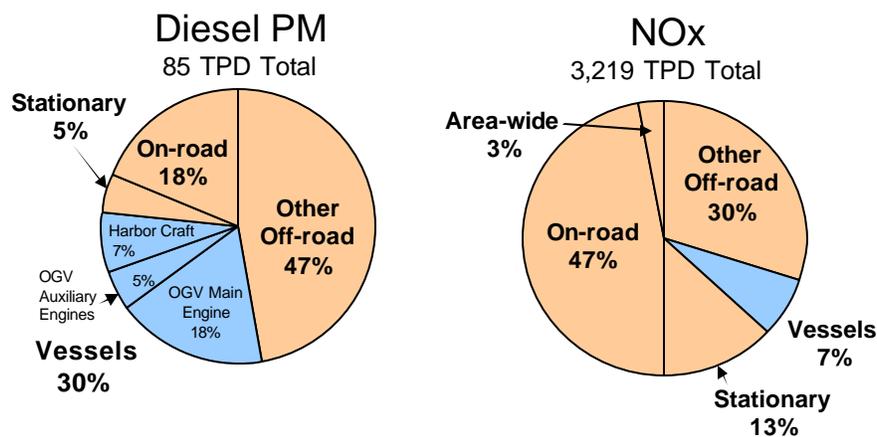
Emissions from Ships Impact Public Health and Air Quality

- ◆ Large and growing source of PM, NO_x, and SO_x emissions
- ◆ Emissions concentrated near population centers
- ◆ Significant localized and regional impacts
- ◆ Contributor to cancer risk and PM mortality
- ◆ Contributor to ambient levels of PM and ozone



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Marine Vessels are a Large Source of California's NO_x & Diesel PM Emissions*



* Source: 2005 ARB Emissions Inventory. Does not include benefit of ARB Ship Auxiliary Engine Regulation

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Multiple Drivers for Action

- ◆ Diesel Risk Reduction Plan
- ◆ State Implementation Plan
- ◆ Environmental Justice Programs
- ◆ Goods Movement Action Plan
- ◆ Port Emission Reduction Plans



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Strategies to Reduce Emissions from Ships

- ◆ Auxiliary Engine Fuel Rule (2005)
- ◆ Rule prohibiting incineration for cruise ships and OGV (2005/2006)
- ◆ Port and Industry Environmental Programs
- ◆ Proposed Shore-Power Rule (late 2007)
- ◆ **Main Engine Fuel Rule (December 2007)**
- ◆ Voluntary Vessel Speed Reduction (late 2007)
- ◆ Green Ships Program (2008)

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Update on Ship Auxiliary Engine Regulation



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Regulation Applies to Auxiliary Engines and Diesel-Electric Engines on Ocean-going Vessels

Motor-Ship



Main Engine for Propulsion (not covered)



Auxiliary Engines for Electricity (covered)



Diesel-Electric



Engines Provide Electricity for both Propulsion & Shipboard Uses (covered)



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Regulation Applies Within 24 Nautical Miles of the California Coastline



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Emission Limit Based on Use of Cleaner Distillate Marine Fuels

- ◆ January 1, 2007 Emission Limit
 - Use marine gas oil up to 1.5% sulfur
 - Use marine diesel oil with a 0.5% sulfur limit
 - Use equally effective emission control strategies

- ◆ January 1, 2010 Emission Limit
 - Use marine gas oil with a 0.1% sulfur limit
 - Use equally effective emission control strategies
 - Fuel supply review

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Option to Pay Noncompliance Fee

- ◆ Unexpected redirection to a California port
- ◆ Inability to purchase complying distillate fuel
- ◆ Fuel found to be noncompliant enroute to California
- ◆ Extension needed for vessel modifications
- ◆ Vessel modifications needed on infrequent visitor

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Noncompliance Fee Schedule

Number of Port Visits	Diesel-Electric Vessels	Other Vessels
1	\$32,500	\$13,000
2	\$65,000	\$26,000
3	\$97,500	\$39,000
4	\$130,000	\$52,000
5 or More	\$162,500	\$65,000

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Alternative Control of Emissions (ACE)

- ◆ Operators may comply using alternative emission control strategies
- ◆ Must achieve equivalent or greater reductions
 - can use fleet average emission reductions
- ◆ Special provision encourages the use of shore-side power
- ◆ Must submit application for review
 - process includes opportunity for public comment

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Marine Advisories and Notices

- ◆ August 2006 Marine Advisory Summarizing the Regulation Requirements
- ◆ 2006 Marine Notices
 - 2006-1: Safety Exemption
 - 2006-2: Noncompliance Fees
 - 2006-3: Recordkeeping
- ◆ 2007 Marine Notices
 - 2007-1: Fuel Mixtures
 - 2007-2: Definition of a “port visit”
 - 2007-3: Responsible parties under charter arrangements

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Industry Compliance

- ◆ Nearly all ships complying by using the distillate fuels
- ◆ Three ship operators have paid noncompliance fees
- ◆ No Alternative Control of Emissions (ACE) applications
- ◆ No exemptions claimed for safety reasons

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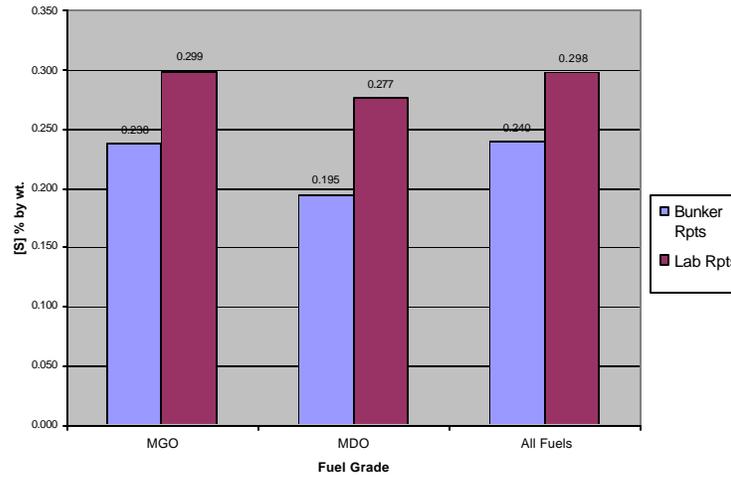
Enforcement Efforts

- ◆ Inspections at Ports throughout California
 - Over 60 vessels boarded
 - Fuels sampled
 - Ship records inspected
- ◆ Findings
 - Vessel operators aware of the regulation
 - Operators have been able to procure compliant fuel
 - Nearly 100% compliance
 - Two possible violations under investigation



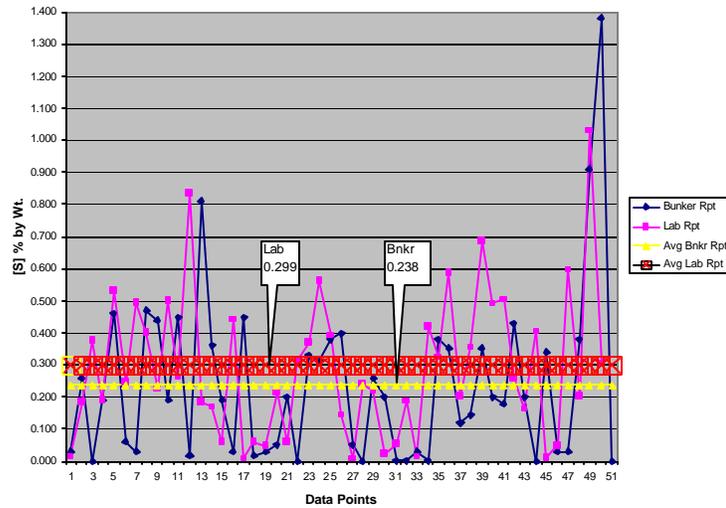
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Auxiliary Engine Inspection Results: Average Sulfur Content Percentage by Weight



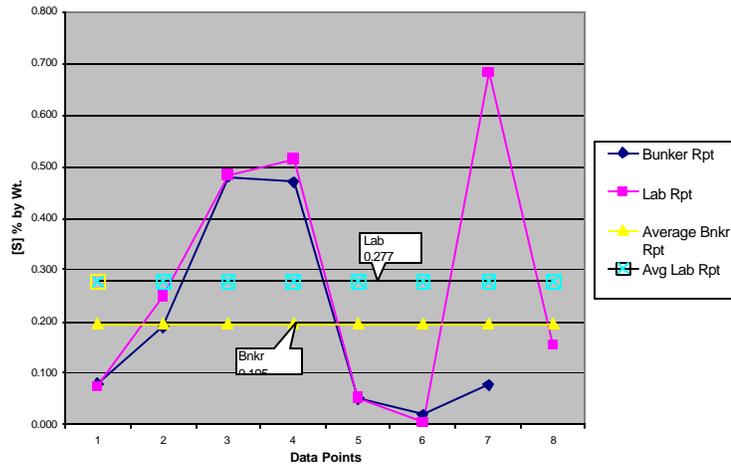
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Auxiliary Engine Inspection Results: MGO Sulfur Content Percentage by Weight



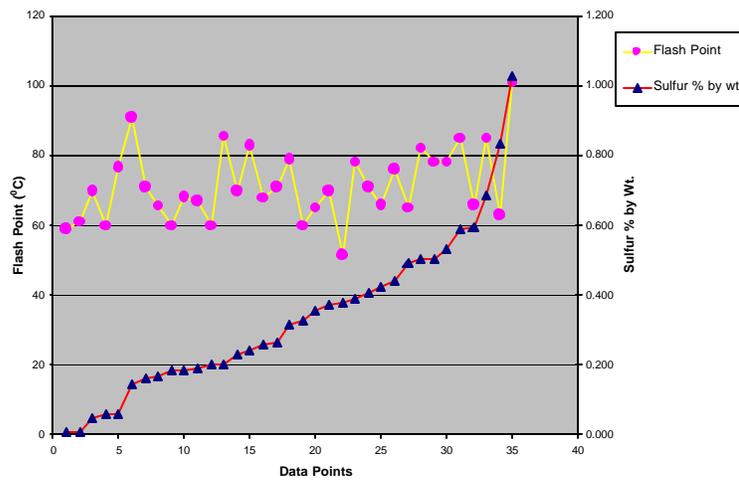
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Auxiliary Engine Inspection Results: MDO Sulfur Content Percentage by Weight



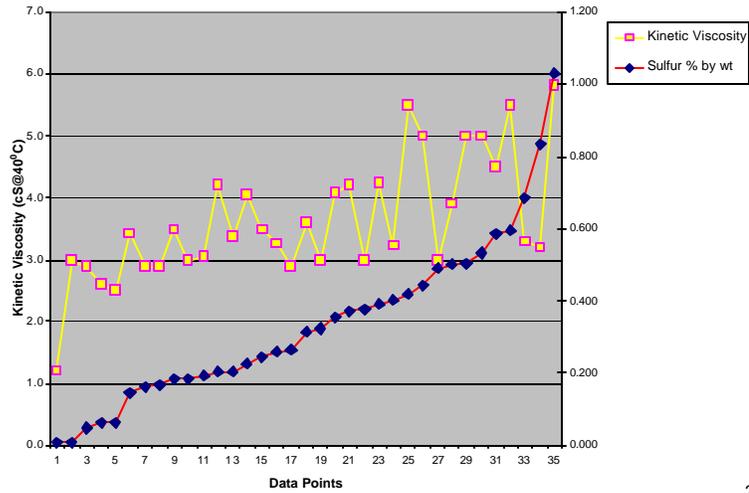
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Auxiliary Engine Inspection Results: Comparison of S% and Flash Point



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Auxiliary Engine Inspection Results: Comparison of S% and Viscosity



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ARB Perspective on U.S. EPA and IMO Efforts to Reduce Ship Emissions



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U.S. EPA Regulation of Ships

- ◆ 2003 Rulemaking
 - NO_x standards consistent with IMO Annex VI
 - only applies to U.S. flagged vessels
 - eliminates exemption for auxiliary engines on U.S. flagged vessels
 - Tier II standards to be proposed in April '07
- ◆ Recent direct final regulation to extend the deadline for Tier II standards
- ◆ Evaluating Sulfur Emission Control Area (SECA) for North America

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U.S. Submittal to IMO

- ◆ Meet emission limits for PM and SOX equivalent to use of [0.1%] sulfur fuel
 - applies within [200] nm in sensitive regions
 - seawater scrubbers provide another option
- ◆ Tier II & III IMO new engine NOx standards
 - 15-25% below current IMO standards in 2011
 - 80% below tier II level in 2016 for defined areas
- ◆ NOx limits for existing engines
 - 20% reduction for [1985]–1999 engines in 2012

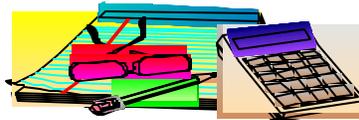
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ARB's View of US/IMO Efforts

- ◆ Prefer international or national emission control of ocean-going ships
- ◆ Support the US submittal to the IMO
- ◆ Disappointed with the national and international progress to date
- ◆ Need to move forward with state efforts until the IMO or EPA adopt measures to achieve the substantial emission reductions necessary to protect public health

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Ship Survey Status



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2007 Ship Survey

- ◆ Purpose
 - collect information on ships visiting California
 - support emission inventory updates and rulemakings for OGVs

- ◆ What Does the Survey Ask?
 - Part I: Contact/Company Information
 - Part II: Ship and Engine Information
 - what modifications were needed to comply with Auxiliary Engine Fuel Rule?
 - what modifications are needed to use low sulfur distillate fuel in main propulsion engines out 24, 50, 100 NM from CA baseline?

<http://www.arb.ca.gov/msprog/offroad/marinevess/survey.htm>

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Status

- ◆ Survey was due by March 31, 2007
 - 77 companies responded
 - over 500 ships
- ◆ Participation is mandatory
 - higher return rate will result in a more informed rulemaking
 - ARB will be contacting ship owners/operators that have not yet submitted survey
 - information is critical for rulemaking
 - late submittals will be accepted

Draft Regulatory Language



Main Goals

- ◆ Require distillate fuels (MDO/MGO) as soon as possible in main engines
 - result in significant reductions earlier
- ◆ Align regulation with auxiliary engine rule
 - simplify implementation
 - minimize the need to carry multiple fuels

Main Engine Regulation is Aligned with Auxiliary Engine Regulation

- ◆ Retains the 24 nautical mile boundary
 - also includes provision to investigate boundaries further off-shore at a later date
- ◆ Contains similar elements
 - most definitions
 - safety exemption
 - recordkeeping
 - alternative control of emissions plan (ACE)
 - non-compliance fee
- ◆ Two-step implementation plan
 - distillate in 0.2-0.5% sulfur range in the near term
 - requirement to meet a 0.1% sulfur limit in the near future

OGV Main Engine Draft Regulatory Proposal

- ◆ Applicability
- ◆ Exemptions
- ◆ Definitions
- ◆ In-use operational requirements
- ◆ Non-compliance fee
- ◆ ACE
- ◆ Recordkeeping

Applicability

- ◆ All ocean-going vessels (U.S. and Foreign-flagged)
 - a vessel greater than or equal to 400 feet in length overall or 10,000 gross tons
- ◆ Main engine on an ocean-going vessel designed primarily to provide propulsion
 - with a per-cylinder displacement of greater than or equal to 30 liters
- ◆ All vessels operating within 24 nautical miles of the California coast

Exemptions

- ◆ Continuous and expeditious navigation through CA waters (no stops or port visits)
- ◆ Auxiliary diesel engines or diesel-electric engines
 - are subject to auxiliary engine rule
- ◆ Emergency generators
- ◆ OGVs owned or operated by any branch of local, state, federal, or foreign government within CA waters
- ◆ Main engines while operating on alternative fuels
- ◆ Safety exemption for severe weather conditions, equipment failure, fuel contamination, or other extraordinary reasons beyond the master's reasonable control

Definitions

- ◆ Most definitions are aligned with the Auxiliary Engine Fuel Rule
- ◆ “Alternative Fuel” definition added
- ◆ “Emergency Generator” definition added
- ◆ “Ocean-going Vessel” definition modified to exclude ocean-going tugs
- ◆ “Port Visit” added and allows shifts within the port boundary
- ◆ “Voyage” definition added

In-Use Operational Requirements

- ◆ Implementation Dates
- ◆ Fuel Requirements
- ◆ Boundary



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Fuel Requirements and Implementation Dates

- ◆ Two step phase in
 - require [0.2 - 0.5%] sulfur MGO/MDO for OGV main engines in 2009
 - actual limit to be determined during regulatory process
 - require 0.1% sulfur MGO in 2013 or 2014
 - date to be determined during regulatory process
- ◆ Tech review of availability of 0.1% sulfur MGO in 2012

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Boundary

- ◆ 24 NM from the California baseline (California Coastal Waters)
- ◆ Feasibility review in [2013-2014] to determine if should extend requirement beyond 24 NM



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Noncompliance Fee Provision

- ◆ Under specific conditions, allow payment of fees to comply with regulation
- ◆ Provide flexibility for ships that need significant modification to comply
- ◆ Allow a compliance path for circumstances beyond the vessel Master's control

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Noncompliance Fee Provision

Number of Port Visits	Noncompliance Fee
1	\$32,500
2	\$65,000
3	\$97,500
4	\$130,000
5 or More	\$162,500

Alternative Control of Emissions

- ◆ Provide flexibility for compliance
- ◆ Public review process of application and ARB preliminary decision
- ◆ Must not result in greater emissions than direct compliance
- ◆ Need to determine how to calculate emissions equivalence

Draft Regulatory Language

Recordkeeping Requirements

- ◆ Keep the following records in English
 - date, local time, and position for:
 - entry into CA waters
 - initiation and completion of fuel switch prior to entry
 - type of fuel used in CA waters
 - type, amount, actual % sulfur of all fuels bunkered
 - fuel switching procedures

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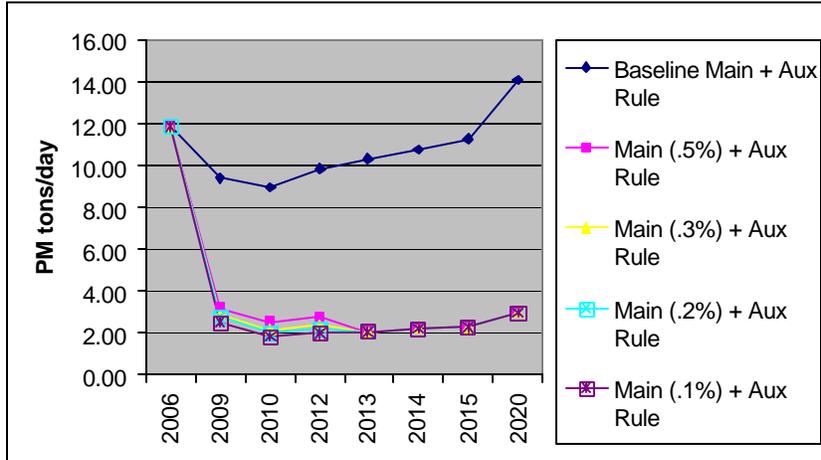
Preliminary Estimates of Emission Reductions



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Preliminary Estimates of Emissions Reductions

**PM Emissions for Main Engine by S%
(Includes Auxiliary Rule)**

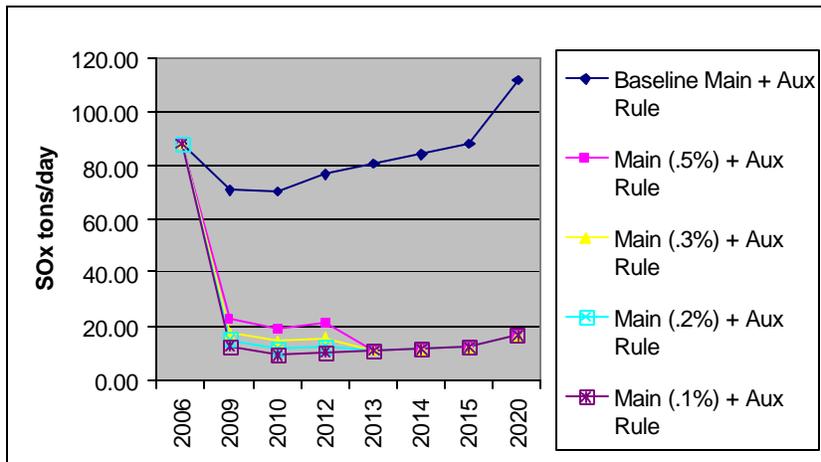


Note: 24 NM Boundary

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Preliminary Estimates of Emissions Reductions

**SOx Emissions for Main Engine by S%
(Includes Auxiliary Rule)**

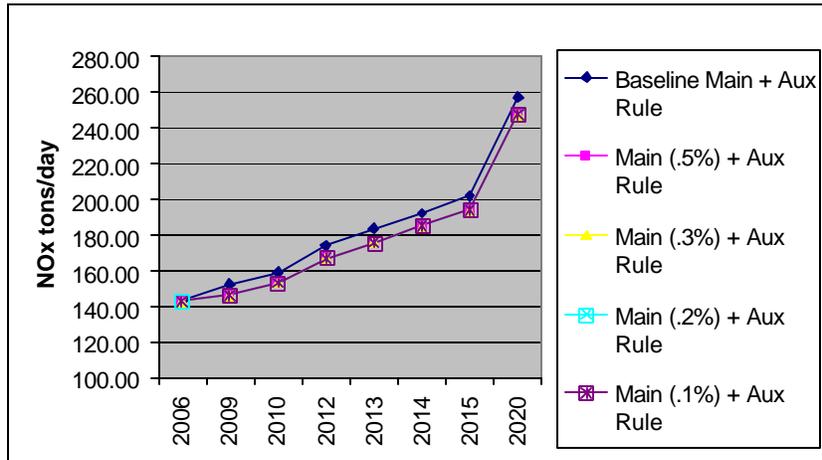


Note: 24 NM Boundary

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Preliminary Estimates of Emissions Reductions

**NOx Emissions for Main Engine by S%
(Includes Auxiliary Rule)**



Note: 24 NM Boundary

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Implementation Considerations



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Implementation Considerations

Information Gathering Efforts

- ◆ ARB held technical discussions in April/May
 - engine makers
 - MAN
 - Wärtsilä
 - vessel operators/owners that are using distillate in auxiliary and main engines
 - marine engineers/navel architects
- ◆ Efforts to continue during rulemaking
 - Maritime Working Group meeting (July 24th)
 - further technical discussions to address key considerations
 - encourage additional input

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Implementation Considerations

Fuel Switching is Feasible

- ◆ Large two-stroke engines can operate on low-sulfur marine distillate fuels
- ◆ Several operational parameters need to be managed
- ◆ Ship-specific fuel switching procedures based on ship configuration are important

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Implementation Considerations

Key Considerations

- ◆ Viscosity/fuel temperature
- ◆ Tankage/fuel system
- ◆ Fuel availability
- ◆ Fuel sulfur limit
- ◆ Cylinder lubricants and feed rates
- ◆ Length of operation on distillate
- ◆ Fuel switching procedures/crew training
- ◆ Fuel compatibility

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Implementation Considerations

Fuel Viscosity

- ◆ Fuel pumps operate best with a viscosity greater than about 2 centistokes (cSt)
- ◆ ISO specification for DMA grade fuel (MGO) is 1.5 to 6.0 cSt@40°C (onroad diesel is 1.9-4.1)
- ◆ Most fuel from inspection reports is > 3 cSt
- ◆ Ship operators can increase fuel viscosity with a fuel cooler or fuel chiller
- ◆ Some ship operators may be able to specify a minimum fuel viscosity

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Implementation Considerations

Tankage and Fuel System

- ◆ Some vessels may need to modify their tanks and fuel handling system to increase their capacity for distillate fuel & to aid fuel switching
 - Add a new tank
 - Segregate an existing tank
 - Costs expected to be in the range of \$50 to \$100k for a typical cargo ship
- ◆ Some vessels may be able to convert an existing HFO tank to distillate if a smaller HFO tank is available
- ◆ Fuel supply and recirculating pumps also operate best with a viscosity greater than 2 cSt

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Implementation Considerations

Fuel Availability

- ◆ Critical aspect of rule implementation
- ◆ ARB cannot mandate requirements for foreign fuel suppliers
- ◆ Expect small increased demand due to main engine regulation
 - 300,000 tonnes marine distillate
 - ~1% of global demand for marine distillate
- ◆ Need a fuel sulfur limit that ensures global availability

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Implementation Considerations

Fuel Sulfur Limit

- ◆ Distillate sulfur cap will depend on findings of fuel availability study
 - working with POLA/POLB on study
 - ARB analyzing available data on global availability of MGO or MDO in 0.1 to 0.5% sulfur range
- ◆ Concerned with global availability of 0.1% sulfur marine distillate
 - POLA fuel availability report
 - inspection results

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Implementation Considerations

Cylinder Lubricants

- ◆ Lubricant properties are optimized for fuel and operating conditions
 - deposition rate
 - acid neutralization
 - detergent properties
 - oil film thickness
- ◆ Lubricating oils
 - base number of the lubricant (BN)
 - feed rate
- ◆ On-board lubricant management systems
 - MAN Alpha Adaptive Cylinder oil Control
 - Wärtsilä Sulzer TriboPack

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Implementation Considerations

Adjustments to Cylinder Lubricant Depend on Length of Operation on Distillate

- ◆ Short duration fuel switching (< 72 hours)
 - may not require changes for lubricant type
 - may require changes in feed rate
- ◆ Longer duration fuel switching (>72 hours)
 - changes in lubricant and feed rate may be needed
- ◆ Typical ship operates main engine less than 30 hours in regulated zone
- ◆ Requires close monitoring of cylinder condition and following engine manufacturer's guidelines

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Implementation Considerations

Fuel Switching Procedures

- ◆ Fuel switching is currently conducted when ships prepare for dry-dock
- ◆ Ship specific procedures need to be followed to control changes in temperature & viscosity
 - prevent fuel gassing and fuel pump damage
- ◆ Equipment can be retrofitted to perform fuel switching automatically
- ◆ Segregated fuel systems allow for quicker fuel switches
 - separate settling and service tanks

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Implementation Considerations

Crew Training

- ◆ Important to ensure that crews are trained in fuel switching procedures
- ◆ Fuel switching will be conducted more frequently for vessels visiting California
- ◆ Procedures available from engine manufacturers
- ◆ Procedures will vary with the vessel and can be either manual or automated

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Implementation Considerations

Fuel Incompatibility

- ◆ Precipitation of asphaltenes in HFO possible with introduction of distillate
- ◆ Has not been an issue with the Ship Auxiliary Engine Rule
- ◆ Not unique to HFO/distillate fuel switches
- ◆ Minimize duration of time when fuels are mixed – i.e. segregated fuel systems
- ◆ Compatibility testing with onboard kit or in lab

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Next Steps



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Next Steps

- ◆ Maritime Technical Working Group
 - July 24, 2007
 - Discussion topics:
 - current global availability of distillate
 - fuel properties
 - switching procedures
 - greenhouse gas impacts
- ◆ Collect and analyze data from survey
- ◆ Continue to investigate fuel switching impacts
- ◆ Investigate fuel availability and cost impacts
- ◆ Monitor need to amend auxiliary engine rule
- ◆ Board consideration – December 2007

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