Air Emissions from Marine Vessels

Report to the Joint Standing Committee on Natural Resources

Maine Department of Environmental Protection
Bureau of Air Quality

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** Cover Photo by Catherine Richardson, Maine DEP*

Introduction

In November 2003, the Maine Department of Environmental Protection, Bureau of Land and Water Quality prepared a legislative report outlining the environmental issues relating to marine vessels. While this report focused mainly on greywater and blackwater discharges, it identified certain air quality concerns relating to ships. The report recommended that Maine DEP Bureau of Air Quality further study these issues.

In the legislation that resulted from the Land and Water report, S.P. 387 / L.D. 1158 "An Act to Protect Maine's Coastal Waters" (PL 2004, c.650, §6), the Maine State Legislature directed the DEP to prepare the following:

> "Sec. 6. Report concerning air emissions. The Department of Environmental Protection shall submit a report to the joint standing committee of the Legislature having jurisdiction over natural resources matters by January 15, 2005 concerning issues related to air emissions from vessels. The report must include draft legislation necessary to implement any proposal. The committee may report out legislation during the First Regular Session of the 122nd Legislature relating to air emissions from vessels."

This document addresses the air quality impacts of all types of marine vessels in Maine, potential health threats due to marine engine emissions, laws and rules pertaining to marine vessels at the international, national and state levels, options Maine could consider in addressing marine vessel emissions and the Department's recommendations.

Section 1. Air Quality Impacts from Marine Vessels

1.1 Air Pollutants from Vessels

The US Environmental Protection Agency has found that marine vessels can contribute to deterioration of air quality in ports and along coastal areas.[1] Most marine vessels operate using diesel engines fueled by either diesel (distillate) or residual (a much higher sulfur) fuel. Diesel exhaust is made up of hundreds of components, both gases and particles. Some of the gaseous components include nitrogen compounds (e.g. nitrogen oxides), sulfur compounds, carbon dioxide and carbon monoxide.[2] These emissions contribute to several of Maine's air pollution concerns, as outlined below.

Ozone

Nitrogen oxides combine with volatile organic compounds in the presence of sunlight to form ozone air pollution. On April 15, 2004, the US Environmental Protection Agency (EPA) classified 108 communities in eight counties along Maine's coast as nonattainment for the eight-hour ozone standard.[3] For the three-year period from 2002 through 2004, the Mid-Coast nonattainment area (including Acadia National Park) continued to show a monitored violation of the eight-hour ozone standard.

Breathing elevated levels of ozone can irritate the respiratory system, reduce lung function, aggravate asthma, inflame and damage the cells lining the lungs and may aggravate chronic lung disease.[4] During the Ozone Season (April 1 to September 30), ozone air pollution can rise to unhealthy levels. During the 2001 and 2002 ozone seasons, where meteorological conditions (sunlight, temperature and wind direction) were conducive to transporting and producing ozone in Maine, air quality levels reached "Unhealthy for Sensitive Groups" or higher on 15 days and 17 days, respectively. During the 2003 and 2004 ozone seasons where meteorological conditions were not conducive, air quality levels still reached the Unhealthy for Sensitive Groups level on 5 days (17 monitors) and 1 day (2 monitors), respectively.[5]

Acid deposition

Nitrogen oxides and sulfur dioxide are the primary sources of acid rain (acid deposition). Acid deposition causes lakes and steams to become acidified, damages trees and forest soils, and deteriorates structures and paint.[6] The high sulfur content of the residual fuel used by ocean-going marine vessels adds to those engines' emissions of acidic sulfur compounds.

Particle pollution

Particulate matter, or particle pollution, is made up of both solid particles and liquid droplets. Particle pollution can aggravate asthma, increase respiratory symptoms like coughing and difficult or painful breathing, and has been linked to chronic bronchitis, decreased lung function and premature death.[7] Diesel particulate matter (DPM), consists of fine particles ($PM_{2.5}$; particles having a diameter smaller than 2.5 μm) and ultrafine particles (having a diameter smaller than 0.1 μm) that can penetrate deep into the lungs. Diesel particles are made up of carbon bound with organic compounds. Many of the

organic components found in diesel exhaust are known to cause, or are suspected of causing, mutations and/or cancer.[8]

Currently all monitors in Maine are showing attainment of the annual and 24-hour particle pollution ($PM_{2.5}$) standards. Air quality levels due to particle pollution reach moderate levels frequently during the winter and summer months. Moderate air quality levels were reached on 148 days in 2002, 106 days in 2003 and 93 days in 2004. Unhealthy for Sensitive Groups air quality levels were reached on four days in 2002, five days in 2003 and one day in 2004, primarily due to transport from forest fires and major source regions southwest of Maine.[9]

Regional haze

Regional haze, or reduced visibility, results from particle pollution. This is of particular concern in Class I areas in Maine (Acadia National Park, Moosehorn National Wildlife Refuge and Roosevelt Campobello International Park), where a blanket of haze can obscure the views that attract many tourists to the park. Under federal haze regulations, Maine is required to develop a plan by 2008 to reduce haze-forming pollutants in Class I areas.[10] Much of the haze in the East is made up of sulfate particles and the high sulfur content of residual fuels may exacerbate this problem.

Climate change

Scientists have observed an increase in average global temperature since 1861, when instruments first began recording temperature. The 1990s are the hottest decade on record with 1998 being the hottest year. As a result, snow cover and ice extent have decreased and sea levels have risen. Scientists attribute this global change in temperature and climate to increased concentrations of greenhouse gases, particularly carbon dioxide (CO_2) in the atmosphere. CO_2 emissions result from the combustion of fossil fuels, such as the diesel and residual fuels burned in marine engines. Climate models predict a wide array of impacts due to climate change, including more extreme high temperatures and increased intensity of precipitation events.[11]

1.2 Maine Marine Vessel Emissions

Inventory

Maine has 3480 miles of coastline[12] with six cargo ports[13] and 13 cruise ship ports[14] (five of the cargo ports are also cruise ports). While freight traffic has remained steady or decreased slightly at many of Maine's ports, it has more than doubled over the last decade at the state's largest port, Portland Harbor.[15], Cruise ship traffic is heaviest in Bar Harbor, which experienced 78 cruise ship calls in 2003, while Portland received 22 calls and Bangor, Belfast, Boothbay Harbor, Bucksport, Camden and Rockland received a total of 42 calls combined.[16] On the recreational side, Maine has 5700 lakes,[17] many of which are enjoyed by the 61,000 registered Maine recreational vessels[18] as well as out-of-state visitors.

Based on data from Maine's 2002 National Emissions Inventory and the MANE-VU (Mid-Atlantic/Northeast Visibility Union) 2002 Emissions Inventory, commercial marine vessels (cargo ships entering and leaving Maine ports) contribute approximately 166 tons of volatile organic compounds (VOC), 1134 tons of nitrogen oxides (NOx), 374 tons of carbon monoxide (CO), 124 tons of sulfur dioxide ($SO_{2)}$ and 91 tons of particulate matter (PM_{10}) per year. Each of these emissions levels makes up 1% or less of the total inventory from all source categories (nonroad engines, onroad vehicles, stationary, and area sources). As a portion of mobile sources (both onroad and nonroad), commercial marine vessels contribute 2% of the NOx, 5% of the SO_2 and 3% of the PM_{10} annually.

By comparison, the inventories found that recreational vessels emit approximately 7574 tons of VOC (5% of the total inventory), 647 tons of NOx (1%), 20,158 tons of CO (3%), 41 tons SO_2 (less than 1%), and 391 tons PM_{10} (1%). As a portion of the mobile sources inventory, recreational vessels contribute 15% of the VOC, 1% of the NOx, 4% of the CO, 1% of the SO2, and 14% of the PM_{10} from mobile sources annually.

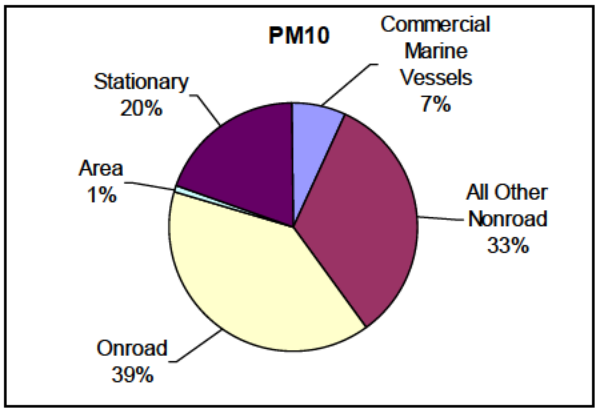
Although emissions from marine commercial vessels appear minor in comparison to other source categories, the Department cannot conclude, based on this inventory data, that marine vessels contribute insignificant levels of air emissions in Maine. The emissions inventory method required by US EPA may not be accurate or robust enough to capture a complete picture of marine vessel emissions. The commercial marine inventory only takes into account cargo ships entering and leaving Maine ports. At this point, Maine DEP's inventory resources do not allow for a more detailed marine vessel emissions inventory, one that would also include the fishing fleet, ferries, cruise ships and tug boats, compare operation in different modes (hotelling, cruising, etc.), and assess land-side port emissions such as cargo-handling equipment, trucks, and locomotives.

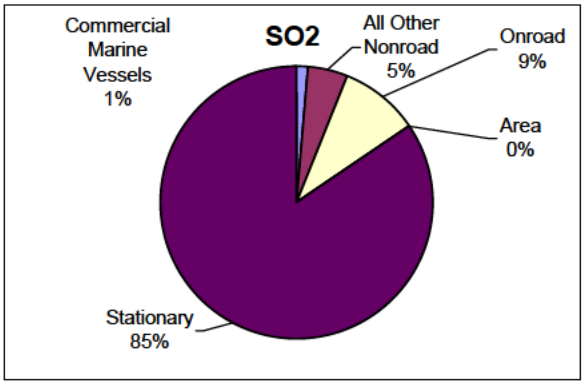
In addition, a single engine on a cruise or cargo ship is large enough that, if it were based on land, would be considered a major source and require mandatory emission controls. Even marine engines built to today's standards could potentially emit as much pollution (on an annual basis) as Maine's largest utility. This, combined with the potential growth in cargo and cruise traffic, the need to address regional haze and concerns that marine

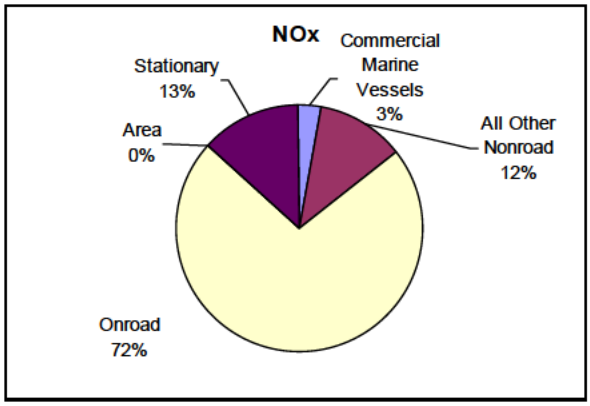
fuel, like home heating oil, will become the outlet of sulfur dumping, prevents the Department from disregarding marine vessels as a potentially important air emissions source.

Fig. 1 Commercial Marine Vessel (Cargo) Emissions in Cumberland County

Emissions from marine vessels may have more significant effects on the local level. While no inventory data is available for the Portland Harbor area, in Cumberland County, where Maine's largest port is located (Portland), commercial marine vessels (cargo only) contribute 3% of the NOx, 1% of the SO_2 and 7% of the PM_{10}.







Monitoring

The Department has not conducted any site-specific monitoring that could indicate how marine vessel emissions impact ambient air quality in surrounding communities.

Nuisance Complaints

The Compliance section of the Maine DEP Bureau of Air Quality reports anecdotally that the Southern Maine Regional Office (Portland) receives approximately two complaints per year relating to cruise ship emissions and the Eastern Maine Regional Office (Bangor) has received a few complaints relating to Maine Maritime Academy vessels in Castine.[19]

Section 2. Legal Framework

Air emissions from commercial marine vessels are addressed at both the national and international level. States are limited in the actions they may take in this area; Section 209 of the Clean Air Act Amendments of 1990 prohibits states from adopting or enforcing any standard relating to the control of emissions from nonroad engines or nonroad vehicles. Section 209 provides one exception to this prohibition, in that States can adopt and enforce such standards if they are identical to standards adopted by the State of California. California has not adopted its own emission standards for marine engines, so Maine cannot take advantage of this exception at this time. However, Maine and other states have implemented voluntary pollution reduction programs to limit marine vessel emissions. Some of these programs are detailed in Section 4 of this report.

Table 1 summarizes and compares the marine diesel engine emission standards outlined in this section and Table 2 summarizes the fuel standards.

2.1 International Agreement

The International Maritime Organization (IMO) International Convention for the Prevention of Pollution from Ships (MARPOL), a combination of two treaties adopted in 1973 and 1978, is the primary international convention addressing prevention of marine pollution by ships. MARPOL Annex VI, Prevention of Air Pollution from Ships, was adopted in 1997 (a.k.a. 1997 Protocol). To enter into force, Annex VI required ratification by 15 nations representing more than 50% of world shipping tonnage. The fifteenth nation ratified Annex VI on May 18, 2004 and it will enter into force on May 19, 2005.[20]

The United States has not ratified Annex VI at this point, however, Annex VI requirements will apply to US-flagged ships when operating in the waters of Parties to (countries that have ratified) the 1997 Protocol. The Annex VI requirements will go into effect for US-flagged ships three months after the US signs the Protocol.[21]

The MARPOL Annex VI[22] regulations address a number of air pollutants in various ways:

Ozone-depleting substances
Annex VI prohibits the deliberate emissions of, and new installations containing, ozone depleting substances.

Nitrogen oxides (NOx)
Annex VI limits emissions of nitrogen oxides from diesel engines with power output greater than 130 kW (kilowatts) installed on a ship that was either constructed after January 1, 2000 or that has undergone a major conversion on or after January 1, 2000.

Sulfur oxides (SOx)
Annex VI sets a world-wide limit on sulfur content of 4.5% for any fuel oil used on board ships. The regulation also allows for the designation of SOx emission control areas wherein sulfur content of fuel oil used onboard ships is limited to 1.5%. The IMO will monitor worldwide sulfur content once Annex VI enters into force.

Volatile organic compounds (VOC)
Annex VI allows Parties to the Protocol (i.e. countries that have ratified MARPOL) to regulate VOC emissions from tankers in ports or terminals under their jurisdiction.

Shipboard incineration
Annex VI requires that shipboard incineration occur only in a shipboard incinerator. Incinerators installed on board a ship on or after January 1, 2000 must meet requirements laid out in the regulation, and incineration of certain materials is prohibited or limited to certain conditions.

Fuel oil quality
Fuel oil used on board ships subject to Annex VI must meet certain standards laid out in the regulation.

Survey and certification
The above requirements are enforced through the survey/inspection of ships subject to Annex VI. After a ship is surveyed, it will be issued an International Air Pollution Prevention Certificate and is subject to subsequent surveys and inspections.

2.2 Federal Regulations

Section 213 of the Clean Air Act Amendments of 1990 requires the US Environmental Protection Agency (EPA) to promulgate and revise regulations that set standards for emissions from nonroad engines and vehicles (including marine vessels) if these engines and vehicles are found to cause or contribute to air pollution.[23] EPA has begun to address marine vessel emissions through a series of rulemakings.

Emission Standards

Tier 1

In 2003, EPA adopted the first set of standards (Tier 1) to affect marine diesel engines with power ratings at or above 37 kW. The Tier 1 standards adopted in this rulemaking (68 FR 9746, February 28, 2003; 40 CFR Part 94) are equivalent to the MARPOL NOx limits for marine diesel engines with per-cylinder displacement of 2.5 to 30 liters (engine categories 1 and 2). In addition, EPA adopted MARPOL-equivalent standards for new marine diesel vessels with displacement at or above 30 liters per cylinder (category 3). The Tier 1 standards apply to engines built from 2004 through 2006, at which time the Tier 2 standards go into effect.[24]

Tier 2

In 1999 EPA finalized regulations (64 FR 733000, December 29, 1999; 40 CFR Part 94) that set standards for emissions from new marine diesel engines with a power rating at or above 37 kilowatts (categories 1, 2 and 3). This regulation applies to emissions of nitrogen oxides plus total hydrocarbons (NOx + THC), particulate matter (PM), and carbon monoxide (CO) with varying standards and effective dates (ranging from engines built in 2004 through those built in 2007) depending on engine category and size.[25]

Recreational marine engines

In 1996 EPA finalized regulations (61 FR 52088, October 4, 1996; 40 CFR Part 91) controlling emissions of NOx + THC from gasoline spark-ignition marine engines, specifically outboard engines, personal watercraft and jet boat engines. The regulation requires increasingly stringent emission levels on a corporate fleet average basis over a period of time from 1998 to 2006.

In 2002, EPA finalized regulations (67 FR 68242, November 8, 2002; 40 CFR Part 94) adopting exhaust and crankcase emission standards for recreational marine diesel engines with power ratings greater than or equal to 37 kW. The standards apply to emissions of HC (hydrocarbons), NOx, CO and PM beginning in 2006. Under this same rulemaking, EPA adopted voluntary emission standards, known as the Blue Sky Series, that are more stringent than the mandatory standards and intended to encourage low-emission technologies. [26]

Future standards

In a May 2004 advance notice of proposed rulemaking, EPA announced its intent to consider standards for new marine diesel engines with per cylinder displacement below 30 liters (categories 1 and 2), that would apply to commercial (excluding oceangoing vessels), recreational and auxiliary engines. The standards under consideration would aim toward large reductions in particulate emissions through the use of advanced emission control technology and could apply as early as 2011.[27]

Table 1. Summary of Emissions Standards for Marine Diesel Engines

Standard	Engine				Emissions (g/kW-hr)				Model Year
	Category	liters displaced/cylinder	rated power (kW)	Speed, rpm	NOx	NOx +THC	PM	CO	
MARPOL			>130 kW	N < 130	17.0				May 19, 2005* (Jan. 1, 2000)
				130 ≤ N <2000	45.0 x N $^{-0.20}$				
				N >2000	9.8				
EPA Tier 1	1, 2, 3	≥ 2.5		N < 130	17.0				2004 - 2006
				130 ≤ N <2000	45.0 x N $^{-0.20}$				
				N >2000	9.8				
EPA Tier 2	1	<0.9	≥37 kW			7.5	0.40	5.0	2005
		0.9 - 1.2	all power levels			7.2	0.30	5.0	2004
		1.2 - 2.5	all power levels			7.2	0.20	5.0	2004
		2.5 - 5.0	all power levels			7.2	0.20	5.0	2007
	2	5.0 - 15.0	all power levels			7.8	0.27	5.0	2007
		15.0 - 20.0	< 3300 kW			8.7	0.50	5.0	2007
		15.0 - 20.0	≥ 3300 kW			9.8	0.50	5.0	2007
		20.0 - 25.0	all power levels			9.8	0.50	5.0	2007
		25.0 - 30.0	all power levels			11.0	0.50	5.0	2007
	3	> 30.0	all power levels	Final Tier 3 standards will be promulgated by April 27, 2007					2007
EPA Recreational Marine Diesel		< 0.9	≥ 37 kW			7.5	0.40	5.0	2007
		0.9 - 1.2	all power levels			7.2	0.30	5.0	2006
		1.2 - 2.5	all power levels			7.2	0.20	5.0	2006
		≥ 2.5	all power levels			7.2	0.20	5.0	2009
EPA Voluntary "Blue Sky Series" Standards	1 and recreational diesel	<0.9	≥37 kW			4.0	0.24		
		0.9 - 1.2	all power levels			4.0	0.18		
		1.2 - 2.5	all power levels			4.0	0.12		
		2.5 - 5.0	all power levels			5.0	0.12		
	2	5.0 - 15.0	all power levels			5.0	0.16		
		15.0 - 20.0	< 3300			5.2	0.30		
		15.0 - 20.0	≥ 3300			5.9	0.30		
		20.0 – 25.0	all power levels			5.9	0.30		
		25.0 - 30.0	all power levels			6.6	0.30		

N = rated engine speed (crankshaft revolutions per minute)

*MARPOL VI enters into force May 19, 2005, yet applies to diesel engines installed on a ship constructed on or after January 1, 2000 or a diesel engine which undergoes a major conversion on or after Jan. 1, 2000.

Fuel Standards

Diesel

In June 2004, EPA finalized regulations controlling emissions from nonroad diesel engines and fuels (69 FR 38958; 40 CFR Part 94). While the engine standards promulgated under that rulemaking do not apply to marine engines, the fuel standards do. Beginning June 1, 2007, refiners will be required to produce marine diesel fuel with a maximum sulfur content of 500 ppm (parts per million). Beginning June 1, 2012, maximum sulfur content of marine diesel produced at refineries will be reduced to 15 ppm. Entities farther downstream in the distribution process have later compliance dates.[28]

Residual

Federal sulfur standards apply only to diesel, or distillate, fuel and not to residual fuel. Residual refers to the heavier number 6 fuel oil that remains after the distillate fuel oils and lighter hydrocarbons are distilled in the refining processes.[29]

In Maine in 2002 (the most recent year for which data is available) 80% of the fuel sold for vessel bunkering was residual fuel.[30] Residual fuel has a sulfur content averaging to 25,000 ppm (2.5%)[31] and a maximum of 45,000 ppm (4.5%) under MARPOL Annex VI (beginning May 19, 2005). By comparison, onroad diesel (used by heavy trucks, etc.) cannot exceed 500 ppm (0.05%) currently and 15 ppm (0.0015%) by 2006. Stationary sources in Maine that burn liquid fossil fuels are required to use fuel with a sulfur content no greater than 15,000 ppm (1.5%) for sources in the Portland Peninsula Air Quality Region and 20,000 ppm (2.0%) in the rest of the state.[32]

Table 2. Marine Fuel Standards

Standard	Applicability	Sulfur Content		Effective Date	Downstream compliance dates
		ppm*	%		
MARPOL	Any fuel used on board ships	45,000	4.5	May 19, 2005	N/A
	Sox Emission Control Areas	15,000	1.5		N/A
EPA	Distillate Fuel***	500	0.05	June 1, 2007	June 1, 2010-December 1, 2010**
	(marine diesel)	15	0.0015	June 1, 2012	June 1, 2014 and beyond

*ppm = parts per million

**The first compliance date applies to refiners and importers. Facilities downstream in the distribution system (i.e. small refiners, terminals, bulk plants, whole-sale purchaser-consumers and retail) have extended compliance dates to smooth the transition to 500 ppm and 15 ppm sulfur fuel.

***EPA has set no standards for the heavy, high-sulfur residual fuel used by most ocean-going vessels.

Section 3. State Programs and Options for Maine

Marine diesel engines have a very long lifespan; the California Commercial Harbor Craft survey found the commercial ships operating in California's coastal waters ranged in age from new to 99 years old, with an average vessel age of 30 years.[33] If similar vessel age characteristics apply elsewhere, then approximately 30 years after EPA's marine engine regulations go into effect, about half of the marine engines on the water will still be older, more polluting models. For this reason, areas around the country have found it necessary to implement other measures, such as cleaner fuels and voluntary emission reductions to see more short-term improvements in air quality impacts from marine vessels. This section reviews steps various states have taken toward reducing pollution from marine vessels—both regulatory and voluntary—within the constraints of the Clean Air Act.

3.1 Regulatory Programs

Visible Emission Standards—Alaska
The State of Alaska's Marine Visible Emissions Standards statute (18 AAC 50.070) sets standards for maximum opacity (reduced visibility) of emissions from ships operating within three miles of the Alaska coastline.[34] The Alaska Department of Environmental Conservation conducts opacity monitoring of cruise ships and ferries in Alaska's ports to ensure compliance.[35]

Maine currently has two opacity regulations: Chapter 101 Visible Emissions Regulation which applies to stationary sources and Chapter 146 Diesel Powered Motor Vehicle Emission Standard which applies to heavy duty diesel vehicles. The Department has consulted with the Maine Attorney General's Office, which advises that neither of these rules ought to be interpreted to apply to marine vessels.[36] In addition, the AG's Office advises that state-specific opacity standards for large, ocean-going marine vessels could conflict with Section 209 of the Clean Air Act, and would have to be drafted carefully to minimize preemption concerns.[37]

Cruise Ship Incineration Ban—California
In August 2004, the California legislature passed a bill prohibiting onboard incineration on cruise ships operating within three miles of the California coast. The governor signed the bill in September 2004 and it goes into effect January 1, 2005.[38]

Low-Sulfur Diesel—California
On November 18, 2004, the California Air Resources Board approved a proposal to limit the sulfur content of diesel used in locomotives and harborcraft to 15 ppm (0.0015%) beginning January 1, 2006, in the South Coast area and January 1, 2007, in the rest of the state.[39]

Anti-Idling Legislation—California
In 2002, the California Legislature passed and the governor approved Assembly Bill 2650, which requires marine terminals at the ports of Oakland, Long Beach, and Los Angeles to carry out their functions in a manner that reduces the amount of truck engine idling at terminal entrances and authorizes fines on terminals when excessive idling occurs.[40] Other states, including Illinois,[41] Massachusetts,[42] New Jersey,[43] and Texas, have introduced similar legislation intended to limit idling specifically at marine terminals.[44]

No Increase in Emissions—Los Angeles and Long Beach, CA
In August 2004 the California Legislature passed Assembly Bill number 2042, which, if signed by the governor, would require the South Coast Air Quality Management District (SCAQMD) to establish a baseline for air quality for the Ports of Los Angeles and Long Beach, based on 2004 emissions from oceangoing vessels, harbor craft, cargo handling equipment, locomotives and commercial motor vehicles. The bill directs SCAQMD and the Ports to enter into a Memorandum of Agreement that requires, among other provisions, that air pollution at the Ports not exceed that baseline beginning January 1, 2006.[45]

3.2 Voluntary Programs

North West Cruise Ship Association Memorandum of Understanding—Hawaii
The North West Cruise Ship Association (NWCA) and the State of Hawaii entered into a Memorandum of Understanding (MOU) in October 2002 to implement environmental goals, policies and practices. Along with wastewater, solid waste and hazardous waste management practices, the MOU addressed air emissions. Specifically, the members agreed to not use incinerators in any Hawaiian ports, limit visible emissions to 20% opacity, continuously monitor stacks' visible emissions while in Hawaiian waters, and limit sulfur content of fuel to less than 2.8% (28,000 ppm).[46]

Marine Shipping Retrofit Program—California
The California Air Resources Board Maritime Working Group—made up of participants from California air districts, USEPA, the US Department of Transportation's Maritime Administration, environmental groups, ship owner-operators, engine manufacturers, and control technology vendors—plans to retrofit two to five ocean-going vessels over two to three years, adding more projects if funding allows. The group's five principal objectives are to: 1) improve their understanding of ship activities and emissions; 2) evaluate potential control technologies; 3) develop partnerships and funding mechanisms; 4) implement retrofit technologies; and 5) document results. The group set an initial target of $1 million to fund the demonstration, with anticipated funding coming from the air districts, participating ports and federal agencies.[47]

West Coast Diesel Emissions Reduction Collaborative

A Collaborative made up of federal agencies, Canada, Mexico, and state, local, non-profit and private sector partners from Alaska, California, Oregon and Washington has developed a plan to reduce air pollution emissions from diesel sources along the West Coast. In addition to programs designed to tackle emissions from diesel trucks and locomotives, the collaborative will address marine emissions in a proposed $1.8 million shore power project in Seattle. Two cruise liners will be connected to the Seattle electric grid to eliminate "hotelling" emissions for 100 percent of cruise liner traffic in downtown Seattle.[48]

No Net Increase of Emissions—Port of Los Angeles

The Port of Los Angeles has a goal of no net increase of emissions from the Port over a baseline year of 2001. The Port has implemented a number of strategies to meet the no net increase goal, as the Port grows and shipping increases.

Voluntary Speed Reduction

In May 2001, the Port of Los Angeles, US EPA, the California Air Resources Board, and the South Coast Air Quality Management District entered into a Memorandum of Agreement with the shipping industry to voluntarily reduce ships' speed (12 knots within 20 miles of shore) as they enter and leave the Ports of Los Angeles and Long Beach. Speed reduction reduces fuel consumption and emissions; the Port reports that since the program began NOx emissions have been reduced by more than a ton per day.[49]

Alternative Maritime Power

In 2004 the Port opened the first container terminal in the world to use Alternative Maritime Power (AMP). While at dock, AMP-equipped ships plug in to shore-side electrical power, rather than burning diesel fuel to generate power. Most of the tugboats in the Port also plug into electrical power while they wait for their next call, rather than idling their engines.[50]

Electrified equipment

All of the more than 50 container cranes in the Port are electric, rather than diesel-powered.[51]

Emulsified diesel in port terminal equipment

The Port offers an incentive program for terminal operators to use cleaner fuels in their equipment. The Port of Los Angeles Clean Air Program provided funding to offset the higher cost of the fuel. Approximately 300 yard tractors and other types of cargo handling equipment operate using emulsified fuel, at a rate of about 1.5 million gallons per year.[52]

Retrofit port terminal equipment with diesel oxidation catalysts

The Port has provided approximately 500 diesel oxidation catalysts (DOCs) to terminal operators, with a goal of installing DOCs in all diesel-powered terminal equipment operating in the Port. The DOCs have been used in yard tractors, side and top picks,

forklifts and transtainers. A DOC used in conjunction with emulsified fuel reduces NOx emissions by 20% and diesel particulate matter by over 50%. Ultra Low Sulfur Diesel fuel (15 ppm) further reduces diesel PM by 25%.[53]

Replace switch locomotives

Under a multi-agency funding agreement, the Port will replace existing diesel switch locomotives with a modern fleet, resulting in emissions reductions of more than half, with the added benefit of more efficient movement of cargo.[54]

Tugboat retrofit

The engines in one of the tugboats in the Port were replaced with ultra-low emission diesel engines, resulting in greater emissions reductions than anticipated. This technology is not yet commercially available.[55]

Reduced Port Emissions—Port of Houston Authority

The Port of Houston Authority (PHA) has taken several steps to reduce emissions from Port facilities as part of the State Implementation Plan to achieve attainment of the ozone standard.[56]

Comprehensive Emission Inventory

With a partial grant from the Texas Commission on Environmental Quality (TCEQ), the PHA developed a comprehensive inventory of cargo handling equipment and ship emissions. This inventory not only significantly reduced the estimate of Port emissions over previous estimates, it pinpointed the areas with the highest NOx emissions and where the greatest emissions reductions could be achieved. The PHA opted to reduce emissions at its own facilities first to prove technologies and educate tenants.

Marine Vessels

The PHA repowered two 1,200 horsepower 1972 marine engines with two engines of the same size that meet MARPOL Annex VI standards. The PHA is forming an agreement with the US Coast Guard, US EPA, TCEQ and the Houston-Galveston Area Council to create a program that would offer incentives to commercial marine vessels that voluntarily reduce air emissions while traveling in and out of the Port of Houston.

Cargo handling equipment

The PHA tested emulsified diesel in the cargo-handling equipment at one terminal and currently uses the fuel in 56 pieces of motorized equipment. The manufacturer of the emulsified diesel used by the PHA claims it reduces NOx emissions by 25% and particulate matter emissions by 30% to 50%. The PHA also replaced five yard tractors and two empty container handlers with Tier II (lower emission) models.

Onroad vehicles

The PHA has purchased 33 ultra low emission vehicles (ULEVs) and propane vehicles for its onroad fleet. The PHA plans to modernize its terminal facility, including a new pre-check gate facility that will reduce data processing time for trucks entering the

facility from 22 minutes to six minutes. The TCEQ Diesel Truck Idling Rule prohibits heavy-duty diesel trucks from idling more than five minutes during the ozone season.

Clean Fuel Initiative—Washington State Ferries

The largest ferry system in the world, Washington State Ferries (WSF), has implemented a clean fuel initiative to reduce emissions from its 28 vessels.[57, 58]

Low sulfur diesel

In 2004, WSF will convert its entire fleet to run on low sulfur diesel fuel. WSF estimates that this changeover will reduce by 90% the fleet's sulfur dioxide emissions and at least 30% of its particulate matter.

Fuel conservation

Over time, WSF has purchased more efficient, cleaner-burning engines and equipment for its ferries. In 2002, the ferry service made operational and schedule changes that resulted in substantial reductions in fuel use. WSF estimates that it conserved approximately 767,000 gallons of fuel in 2003 as a result of these changes, with corresponding reductions in emissions.

Biodiesel pilot test

For one year the three ferries that service one of WSF's routes will use exclusively B20 (20% biodiesel, 80% low sulfur petroleum diesel), burning a total of 1.5 million gallons during the test. This pilot program will give WSF information about the feasibility of long-term burning of B20. WSF expects a decrease in emissions of carbon dioxide, sulfur dioxide and particulate matter, and an increase in nitrogen oxides. Funding for this project came from the local utility, Seattle City Light, as part of its endeavor to become greenhouse-gas neutral.

Ultra-low sulfur diesel fuel pilot test

WSF will test the use of ultra low sulfur diesel fuel (ULSD) on one ferry for one year, burning approximately 1.3 million gallons over the test period. The test will result in reductions in sulfur dioxide and particulate matter and give WSF information about the feasibility of using ULSD over the long-term. US EPA Region X and the Puget Sound Clean Air Agency funded this pilot program.

Clean Ferry Emissions Reduction Initiative—New York Harbor

The New York State Energy Research and Development Authority (NYSERDA) has developed a series of programs designed to reduce emissions from the ferry systems that serve New York City Harbor, through retrofitting existing engines and developing advanced technologies for new vessels.[59]

Private Ferry Emissions Reduction Program

In a partnership with New York City Department of Transportation (NYCDOT), NYSERDA developed this two phase program to reduce NOx and $PM_{2.5}$ emissions from

private ferry fleets. The first phase, currently underway, involves surveying the private ferry fleets to collect baseline data, analyze emission reduction technologies and demonstrate selected technologies. In the second phase, the partners will provide incentives to fleet operators to implement the demonstrated technologies. Technologies being considered include: exhaust gas treatment, alternatives to marine diesel fuel, engine modifications and operational changes. In a parallel program spearheaded by NYCDOT and the Port Authority of New York/New Jersey, selective catalytic reduction technology is being demonstrated on the Staten Island Ferries.

Strong Arm Ferry Docker Program

The Strong Arm Docker Program will establish the feasibility of a mechanical quick-docking system for ferry vessels. This system allows engines to idle rather than use high propulsive power to hold the vessel against the dock during passenger loading and unloading, and can result in significant fuel savings and emissions reductions.

Green Ferry Alternatives Program

NYSERDA has initiated a broad study of all options for energy efficiency and environmental achievement, including hull design, propulsion systems and fuels.

Hybrid Marine Propulsion Program

NYSERDA is developing and demonstrating an advanced, hybrid propulsion system for ferry class vessels.

3.3 Maine and Regional Initiatives

Low-Sulfur Diesel—Maine State Ferry Service
Maine's Ferry Service will implement a one-year trial using low-sulfur fuel on one of the system's seven ferries. Beginning December 1, 2004, the *Governor Curtis*, which services the route from Rockland to Vinalhaven, will use diesel fuel with a sulfur content of about 380 ppm, a significant reduction over the currently-used 22,000 ppm sulfur content. The Ferry Service expects to pay about $0.09 per gallon in increased cost. The *Governor Curtis* uses about 100,000 gallons of fuel annually. In addition, in 2006 and 2007, the Service plans to repower two ferries with electronic controls that reduce emissions.[60]

Repowered (Tier II) Engines—Casco Bay Lines
The Casco Bay Island Transit District (CBITD), a quasi-municipal nonprofit corporation, services the islands of Casco Bay with five vessels. CBITD recently repowered one of its ferries with Tier II engines and is having a new vessel built also with Tier II engines that will replace one of the fleet's older ferries.[61]

Clean Marine Initiative—New England
In 2002, Maine teamed up with EPA New England, other New England states and marine trade associations to launch a program to encourage consumers to purchase recreational marine engines that meet the 2006 standards before the standards go into effect. Based on EPA's most recent data (June 2004), 134 retailers participate in the program, out of a total of 1207 in the region. In Maine, 17 of the state's 355 recreational marine dealers participate. In 2003, 84% of marine engines sold at participating retailers region-wide were low polluting marine engines. At Maine's participating dealers, 86% of marine engines sold in 2003 were low pollution engines.[62]

Obviously this program has been highly successful in encouraging the sales of low polluting marine engines at the participating retailers. However only 11% of recreational marine engine dealers region-wide and less than 5% in Maine participate in the program. With only one year remaining before the 2006 standards go into effect, it may not be practical to attempt to expand this program. However, it could be useful to explore the possibility of extending the program to encourage the sales of recreational vessels that comply with the voluntary "Blue Sky" standards adopted by EPA in its nonroad and recreational engine rules.[63]

Sulfur Emission Control Area Designation—Northeast States
The Northeast States for Coordinated Air Use Management (NESCAUM), an interstate association of air quality control divisions in the Northeast states, is looking into the environmental case for creating a SOx emission control area in the Northeast under MARPOL Annex VI. A workshop on the topic is planned for February 2005, with a planned application submission date of December 2005.[64]

Section 4. Recommendations For Maine

While the available inventory and monitoring data do not demonstrate an immediate air quality threat from marine vessels that could justify legislative or regulatory action, the Department does believe that impacts on the local level (not captured in state- or county-wide inventories) and the increase in cargo traffic in Portland do give reason to study the issue further and support voluntary initiatives.

As part of the Bureau of Air Quality's plan for holistic improvement of emissions data, inventory staff will take a more thorough look at emissions from marine vessels over the next few years. Data from this effort will further inform decision-making in this area. In addition, the Department will look into conducting computer modeling to assess the impacts of marine vessel emissions and determine where those impacts will be most significant, particularly in the Portland area. Results from expanded inventory and modeling efforts will inform the Department as to the necessity of additional monitoring in the impacted areas.

In the meantime, due to concerns that marine fuel, like home heating oil, will become the outlet of sulfur dumping and the need to address regional haze, the Department intends to support NESCAUM's regional effort to designate the Northeast as a sulfur dioxide emission control area under MARPOL Annex VI (see "Sulfur Emission Control Area Designation" under Section 3.3). Bureau staff will participate in this developing initiative as appropriate.

The Department also recommends that future improvements and installations at Maine's cargo and cruise ports be developed with an eye to how the expansions will impact air quality and how these impacts can be mitigated (shore-based electric power or low-emission cargo handling equipment, for example).

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