California Environmental Protection Agency

AIR RESOURCES BOARD

TECHNICAL SUPPORT DOCUMENT: INITIAL STATEMENT OF REASONS FOR PROPOSED Rulemaking

PROPOSED REGULATION FOR COMMERCIAL HARBOR CRAFT

Stationary Source Division
Emissions Assessment Branch

September 2007

State of California
AIR RESOURCES BOARD

Technical Support Document:
Proposed Regulations for Commercial Harbor Craft

Public Hearing to Consider

ADOPTION OF PROPOSED REGULATIONS
TO REDUCE EMISSIONS FROM DIESEL ENGINES ON
COMMERCIAL HARBOR CRAFT OPERATED WITHIN CALIFORNIA WATERS
AND 24 NAUTICAL MILES OF THE CALIFORNIA BASELINE

To be considered by the Air Resources Board at a two-day meeting of the Board that will commence on October 25 and may continue to October, 26, 2007, at:

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AIR RESOURCES BOARD

PROPOSED REGULATIONS FOR COMMERCIAL HARBOR CRAFT

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I. INTRODUCTION

The California Air Resources Board's (ARB or Board) mission is to protect public health, welfare, and ecological resources through the effective and efficient reduction of air pollutants, while recognizing and considering the effects on the economy of the State. The ARB's vision is that all individuals in California, especially children and the elderly, can live, work, and play in a healthful environment – free from harmful exposure to air pollution. To achieve this, ARB has adopted numerous regulations to control emissions from many different sources, including diesel engines. Diesel engine exhaust is a health concern because it is a source of unhealthful air pollutants including gaseous and particulate-phase toxic air contaminants (TAC), particulate matter (PM), oxides of nitrogen (NOx), carbon monoxide, and hydrocarbons.

This technical support document (TSD) is an addendum to the Staff Report: Initial Statement of Reasons (Staff Report) and provides more detailed information supporting the development of the proposed regulatory action. As noted in the Staff Report, the proposal consists of two essentially identical regulations, one a regulation developed pursuant to ARB's authority under Health and Safety Code (HSC) sections 43013(b) and 43018, and the other an airborne toxic control measure (ATCM) pursuant to HSC section 39666. Because of this, both regulations will be collectively referred to hereinafter as the "regulation" or "proposed regulation."

The TSD includes information on the ARB's legal authority to adopt the proposed regulation, descriptions of commercial harbor craft, their uses, and the diesel engines used on them along with projected vessel and engine inventories, an evaluation of the need for emission reductions from commercial harbor craft including the corresponding health impacts, a summary and discussion of the proposed regulation, information supporting the technical feasibility of implementing the proposed regulation, the projected emissions reductions along with the associated reduction in health risk, and a discussion of the economic impact of the regulation and the corresponding economic analysis.

A. Need for Proposed Regulation

In 1998, the Board identified diesel PM as a TAC with no Board-specified threshold exposure level. A needs assessment for diesel PM was conducted between 1998 and 2000, which resulted in ARB staff developing and the Board approving the *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (Diesel RRP) in 2000. The Diesel RRP presented information on the available options for reducing diesel PM and recommended regulations to achieve these reductions. The scope of the Diesel RRP was broad, addressing all categories of engines both mobile and stationary, and included control measures for all off-road diesel sources, such as those covered by the proposed regulation. The ultimate goal of the Diesel RRP is to reduce California's diesel PM emissions and associated cancer risks by 85 percent from the 2000 baseline levels by 2020.

In January 2005, a Goods Movement Cabinet Workgroup, created by Governor Schwarzenegger and led by the California Environmental Protection Agency (CalEPA) and the Business, Transportation and Housing Agency, established a policy for goods movement and ports to improve and expand California's goods movement industry and infrastructure while improving air quality and protecting public health. The workgroup worked collaboratively with the logistics industry, local and regional governments, neighboring communities, business, labor, environmental groups, and other interested stakeholders to create a two-phased Goods Movement Action Plan (Action Plan), which outlines a comprehensive strategy to address the economic and environmental issues associated with moving goods via the state's highways, railways, and ports.

In April 2006, the Board approved the Emissions Reduction Plan for Ports and Goods Movement in California as part of the Action Plan. The final phase of the Action Plan was completed in January 2007 and includes a framework that identifies the key contributors to goods movement-related emissions. The Action Plan's emission reduction goals for existing harbor craft engines are 25 percent reductions for both diesel PM and NOx compared to baseline 2001 levels by 2010, 30 percent reductions compared to 2001 baseline levels by 2015, and 40 percent reduction by 2020.

The federal Clean Air Act (CAA) requires U.S. EPA to establish National Ambient Air Quality Standards (standards) for pollutants considered harmful to public health, including fine particulate matter (PM2.5) and ozone. The South Coast and San Joaquin Valley air basins are the two areas in the State that exceed the annual PM2.5 standards. These areas are required by federal law to develop State Implementation Plans (SIPs) describing how they will attain the standards by 2015. The U.S. EPA further requires that all necessary emission reductions be achieved one calendar year sooner – by 2014 – in recognition of the annual average form of the standard. NOx emission reductions are needed because NOx leads to formation in the atmosphere of both ozone and PM2.5; diesel PM emission reductions are needed because diesel PM contributes to ambient concentrations of PM2.5. San Joaquin Valley and South Coast air basins are also in non-attainment for the federal ozone standard. However, they are expected to have until 2023 to attain the federal ozone standard, by invoking the "bump-up" provision in the CAA. The ARB and the districts are working to complete the PM2.5 and ozone SIPs and expect to submit them to the U.S EPA by April 2008 and this fall, respectively.

While all sources of NOx emissions are important, marine vessels, which include commercial harbor craft engines, are one of several key contributors to PM2.5 that will determine whether California is able to meet the 2014 deadline for PM2.5 attainment in the South Coast Air Basin.

Staff is proposing a regulation to reduce diesel PM and NOx emissions from harbor craft vessel engines. The term "harbor craft" includes commercial and charter fishing vessels, ferries, excursion vessels, tugboats, towboats, pilot vessels, crew boats, work boats, and other types of harbor craft. Pleasure craft and ocean-going vessels (ships) are not considered harbor craft, except for ocean-going tug and tow boats.

The regulation is expected to significantly reduce emissions of diesel PM from in-use harbor craft engines. Diesel PM emission reductions are needed to reduce premature mortality, cancer risk, and other adverse health effects from exposure to this TAC. The regulation would achieve the 2015 and 2020 goals for harbor craft in the Goods Movement Action Plan. Staff projects that the regulation would reduce in-use harbor craft diesel PM emissions about 70 percent and NOx emissions about 60 percent from the 2004 baseline by 2020. These emission reductions would occur in areas along waterways, near ports, and in those communities surrounding these areas, as well as further inland.

The regulation would also reduce diesel PM and NOx emissions that contribute to exceedances throughout the State of ambient air quality standards for both PM2.5 and ozone. These reductions would assist California in its goal of achieving state and federal air quality standards.

The emission reductions from the proposed regulation would result in lower ambient PM levels and reduced exposure to diesel PM. Staff estimates that approximately 310 premature deaths statewide would be avoided by year 2025 from implementation of the proposed regulation. The estimated cost benefit of the avoided premature deaths and other health benefits due to the emission reductions are estimated to range from $1.3 to $2.0 billion.

B. Summary of Proposed Regulation

Staff is proposing a regulation that would reduce emissions of diesel PM and NOx from nearly 600 ferries, excursion vessels, tugboats, and towboats in the State. The regulation would achieve these emission reductions by requiring vessel owner/operators to modernize their vessels engines by installing new cleaner engines. The regulation is projected to reduce emissions significantly at a reasonable cost.

The scope of the regulation includes all harbor craft operating in the State but limits the in-use emission reduction requirements to ferries, excursion vessels, tugboats, and towboats. The regulation would require all persons that operate harbor craft vessel in Regulated California Waters (an offshore zone that starts at the California coastline that is generally 24 nautical miles wide) to fuel the diesel engines with clean diesel fuel or its equivalent, monitor their engine operating hours (must have non-resettable hour meters on engines), keep records, and report certain information to ARB. Ferries, excursion vessels, tugboats, and towboats would be required to follow a specified engine replacement compliance schedule (see Chapter V). These vessels would be required to replace all unregulated (also referred to as “Tier 0” or “pre-Tier 1”) and Tier 1 engines with new, lower emitting engines meeting the current U.S. Environmental Protection Agency (EPA) marine engine standards. A schedule accelerated by two years is proposed for vessels with their homeport within the South Coast Air Quality Management District (SCAQMD). This provision will provide early benefits in the

SCAQMD, which is in non-attainment for the federal annual PM2.5 and PM10 ambient air quality standards and 8-hour ozone standard.

The proposed regulation would use the model year and annual hours of operation of each engine to determine when engines would need to be replaced. As an optional compliance method, an owner or operator could comply by demonstrating that the existing engine is as clean as the current new engine standard. Provisions are included to allow additional compliance time for engines that have been rebuilt to a cleaner standard or utilize a retrofit diesel emission control strategy.

The proposed regulation includes requirements for newly acquired vessels and engines, in order to ensure that California's harbor craft fleet becomes cleaner as vessels are added to the California fleet and engines are replaced. The proposed regulation would require that only engines meeting the U.S. EPA marine engine standards in effect at the time of purchase be allowed to be installed as a replacement engine on in-use harbor craft. In other words, a newly acquired engine would be required to meet the U.S. EPA standards that would apply had the engine's model year been the same as the year it was purchased for the installation. Similarly, the engines on new harbor craft would be required to meet the standards in effect for engines with a model year that is the same as the date/year of vessel acquisition. Propulsion engines on new ferries, which contribute a significant portion of the in-harbor emissions from this source category, would also be required to install best available control technology (BACT).

II. REGULATORY STATUS AND PUBLIC OUTREACH

A. Regulatory Authority

ARB has authority under California law to adopt the proposed regulation. California Health and Safety Code (HSC) sections 43013(b) and 43018 provide broad authority for ARB to adopt emission standards and other regulations to reduce emissions from new and in-use nonvehicular sources. Under HSC sections 43013(b) and 43018, ARB is directly authorized to adopt emission standards for marine vessels, as expeditiously as possible to meet State ambient air quality standards and to the extent permitted by federal law. The ARB is further mandated by California law under HSC section 39666 to adopt airborne toxic control measures (ATCM) for new and in-use nonvehicular sources, including commercial harbor craft, for identified toxic air contaminants such as diesel PM.

Under federal and California law, ARB is the primary agency in California responsible for making certain that all regions of the State attain and maintain National Ambient Air Quality Standards (NAAQS). To achieve this, California must adopt all feasible measures to obtain the necessary emission reductions, including measures for mobile sources. The federal Clean Air Act section 209(e)(1) conclusively preempts states, including California, from adopting requirements for locomotive engines and new off-road engines less than 175 horsepower that are used in farm or construction equipment.[1] However, the proposed regulation addresses off-road engines used in marine vessels, rather than those used in locomotives or farm or construction equipment.

Under CAA section 209(e)(2), California may adopt and enforce emission standards and other requirements for off-road engines and equipment not conclusively preempted by section 209(e)(1), so long as California applies for and receives authorization from the Administrator of U.S. EPA. To obtain authorization, the Board must make a finding that the California adopted standards will be, in the aggregate, at least as protective of public health and welfare as applicable federal standards.[2] The Administrator must grant a request for authorization from California unless he finds that ARB's protectiveness finding is arbitrary and capricious, that California does not need the standards to meet compelling and extraordinary conditions, or that the standards and accompanying enforcement procedures are not consistent with CAA section 209.

[1] The California term "off-road" and the federal term "nonroad" refer to the same sources and are used interchangeably. In addition, for purposes of this proposed regulatory action, "nonvehicular" will also be used interchangeably with "offroad" and "nonroad."

[2] CAA section 209(e)(2)(A). Other states may subsequently opt into the California program, but their regulations must be identical to California's requirements. CAA section 209(e)(2)(B).

B. Summary of Existing Regulations and Programs

In-use commercial diesel-fueled harbor craft are not currently subject to either California or federal engine emission standards. However, emissions from new harbor craft engines are subject to U.S. EPA new marine engine standards. These are discussed below.

1. U.S. EPA Marine Engine Standards

Since 1999, U.S. EPA standards have mandated the emission levels for new marine engines used in commercial harbor craft.[3] The standards are tiered and have phased-in effective dates and emission levels dependent on the engine size. The size categories are provided in Table II-1.

Table II-1: U.S. EPA Marine Engine Categories Used in Harbor Craft

Category	Liters per Engine Cylinder	Approximate Horsepower (hp)
Category 1	< 5.0[A]	50[B] to <~2500
Category 2	5.0 to 30[A]	≥750 to <5000

[A] The U.S. EPA has proposed Tier 3 and Tier 4 standards, which, if adopted, will update Category 1 to < 7.0 L/cyl. and Category 2 to 7.0 to 30 L/cyl.
[B] The proposed Category 1 Tier 3 standards include engines rated less than 50 hp.

All of the engines used on harbor craft in California are Category 1 or 2 engines. Category 1 engines are rated at less than 5.0 liters per cylinder (L/cyl) and can range as high as 2,500 horsepower (hp). Category 2 engines range in size from 5.0 L/cyl to 30 L/cyl and can range from about 750 to 5,000 hp. The horsepower ranges for these two categories overlap. The vast majority of the engines on California harbor craft are Category 1 engines. According to the ARB 2004 statewide survey all of the auxiliary engines and about 90 percent of the propulsion engines used on California-based harbor craft are Category 1 engines. The remaining 10 percent of the propulsion engines are Category 2 engines. (ARB, 2004)

The U.S. EPA has proposed in their April 3, 2007, Draft Locomotive and Marine Notice of Proposed Rule Making (NPRM) to modify the breakpoint between Category 1 and 2 engines from 5.0 L/cyl to 7.0 L/cyl. (The primary purpose of the NPRM was the proposal of Tier 3 and Tier 4 locomotive and marine engine standards, discussed in more detail below.) While this change in breakpoint may reduce the number of engines classified as Category 2 in the commercial harbor craft fleet, the largest engines used on commercial harbor craft, primarily tugboat propulsion engines, would still be Category 2 engines. Additionally, while the current Category 1 definition excludes engines less than 50 hp, these smaller engines would be included in Category 1 for Tier 3 standards per the NPRM.

[3] Title 40, Code of Federal Regulations (CFR) Part 94.

In 1999, U.S. EPA adopted Tier 1 standards for larger Category 1 and 2 marine engines that were consistent with the NOx limits adopted through the International Maritime Organization (IMO) (IMO, 1997). These U.S. EPA NOx standards were not mandatory until 2004, however, through the IMO they became retroactive to 2000 once the IMO treaty was ratified by a majority of the participating nations. Consequently, engine manufacturers began manufacturing marine engines compliant with Tier 1 NOx standards in 2000. The smallest marine engines, those less than 50 hp, were initially included in the U.S. EPA's Tier 1 and Tier 2 non-road diesel engine rules and are subject to the same emission limits as their land-based counterparts. Tier 1 standards for these small engines came into effect in 1999 and 2000. Tier 1 engine standards are presented in Table II-2.

Table II-2: U.S. EPA Tier 1 Standards for Marine Diesel Engines Used in Harbor Craft

Category	Horsepower	Engine Speed	Effective Date	PM (g/bhp-hr)[A]	NOx (g/bhp-hr)[A]	NOx + HC (g/bhp-hr)[A]
Small	< 11	-	2000	0.75	-	7.8
	11 to < 25	-	2000	0.60	-	7.1
	25 to < 50	-	1999	0.60	-	7.1
1 and 2	50 to <5000	rpm = 2000	2004	-	7.3	-
		130 = rpm <2000	2004	-	$33.57 X rpm^{-0.2}$	-
		rpm <130	2004	-	12.7	-

(40 CFR Part 94)

[A] Converted standards from 40 CFR 94, which are expressed in grams per kilowatt-hour (g/kW-hr), to grams per brake horsepower-hour (g/bhp-hr), by the following: g/kW-hr X 0.746 = g/bhp-hr

Tier 2 emission standards are presented in Table II-3. The Tier 2 standards became effective for engines made in 2004 to 2007, depending on size (cylinder displacement). The Tier 2 engine standards are about 50 percent more stringent for PM and 40 percent more stringent for NOx than Tier 1 standards.

Table II-3: U.S. EPA Tier 2 Standards for Marine Diesel Engines Used in Harbor Craft

Category	Horsepower	Displacement (liters/cylinder)	Effective Date	PM (g/bhp-hr)[A]	NOx+ HC (g/bhp-hr)[A]
Small	< 11	-	2005	0.60	5.6
	11 to < 25	-	2005	0.60	5.6
	25 to < 50	-	2004	0.45	5.6
1	50 to <100	< 0.9	2005	0.30	5.6
	100 to <175	0.9 to < 1.2	2004	0.22	5.4
	175 to <750	1.2 to < 2.5	2004	0.15	5.4
	≥750 to <~2500	2.5 to < 5.0	2007	0.15	5.4
2	≥750 to <5,000	5.0 to < 15	2007	0.20	5.8

(40 CFR Part 94)

[A] Converted standards from 40 CFR 94, which are expressed in g/kW-hr, to g/bhp-hr, by the following: g/kW-hr X 0.746 = g/bhp-hr

As previously mentioned, the U.S. EPA's April 3, 2007, NPRM includes proposed Tier 3 and Tier 4 standards for Category 1 and 2 marine engines. The proposed Tier 3 standards are presented in Table II-4.

Table II-4: Proposed U.S. EPA Tier 3 Standards for Marine Diesel Engines Used in Harbor Craft

Category	Horsepower	Displacement (liters/cylinder)	Effective Date	PM (g/bhp-hr)	NOx + HC (g/bhp-hr)
1	< 25	<0.9	2009	0.30	5.6
	25 to <100	<0.9[A]	2009	0.22	5.6
			2014	0.22[B]	3.5[6]
	100 to <4960	<0.9	2012	0.10	4.0
		0.9 to <1.2	2013	0.09	4.0
		1.2 to <2.5	2014	0.08[C]	4.2
		2.5 to <3.5	2013	0.08[D]	4.2
		3.5 to <7.0	2012	0.08[D]	4.3
2	≤ 4960	7 to <15	2013	0.10	4.6

(EPA, 2007)

[A] Engines less than 100 hp at or above 0.9 L/cyl. are subject to the corresponding 100-4960 hp standards

[B] Option: 0.15 g/bhp-hr PM / 4.3 g/bhp-hr NOx in 2014

[C] This standard drops to 0.07 g/bhp-hr in 2018 for engines <800hp

[D] This standard level drops to 0.07 in 2018 for engines <800 hp

Table II-5 presents the U.S. EPA's proposed Tier 4 engine standards. Tier 4 standards would apply to engines with a maximum power rating over 800 hp. (EPA, 2007)

Table II-5: Proposed U.S. EPA Tier 4 Standards for Marine Diesel Engines Used in Harbor Craft

Category	Horsepower	Effective Date	PM (g/bhp-hr)	NOx (g/bhp-hr)
1 and 2	800 to <1877	2014	0.03	1.3
	1877 to 4960	2016[A]	0.03	1.3

(EPA, 2007)
[A] Optional compliance start dates are proposed within these model years

The emission reductions projected for the proposed Harbor Craft regulation are dependent on the U.S. EPA promulgating Tier 3 and Tier 4 standards that are at least as stringent and have effective dates no later than as proposed. Earlier effective dates and more stringent Tier 3 standards would provide further reductions.

The U.S. EPA's proposed Tier 4 standards are expected to be achievable only through incorporating exhaust after-treatment into engine design. The U.S. EPA has proposed to exclude engines less than 800 hp from being subject to Tier 4 standards, based primarily on the space and weight limitations of smaller harbor craft. The proposed (ARB) regulation does not require Tier 4 standards to be met for in-use engine compliance due to difficulties in replacing an engine on an in-use harbor craft with one equipped with after-treatment systems. Consequently, this exclusion does not impact the reductions to be obtained through the in-use engine requirements. However, significant additional reductions could be obtained for new-build vessels if these Tier 4 requirements were extended to lower horsepower ranges.

The U.S. EPA's 2007 NPRM discusses, but does not propose, setting rebuild standards for marine engines. The inclusion of rebuild standards for marine engines in U.S. EPA's final rulemaking could provide substantial additional emission reduction benefits for California.

2. <u>ARB Harbor Craft Fuel Standard</u>

In 2004, ARB adopted a fuels regulation and an ATCM that extend the applicability of the California standards for motor vehicle diesel fuel regulations, including a maximum sulfur content of 15 parts per million (ppm), to diesel fuel sold for use in commercial and recreational harbor craft and intrastate diesel-electric locomotives. The fuels regulation (title 13, California Code of Regulations (CCR), section 2299) and ATCM (title 17, CCR, section 93116) apply to diesel fuel sold for use in commercial and recreational harbor craft statewide. These measures became effective in SCAQMD beginning January 1, 2006, and statewide beginning January 1, 2007. Diesel fuel meeting ARB's motor vehicle fuel standards is often referred to as "CARB diesel."

C. Environmental Justice and Public Outreach

1. Environmental Justice

The ARB is committed to integrating environmental justice principles in all of its activities. On December 13, 2001, the Board approved Policies and Actions for Environmental Justice (ARB, 2001), which formally established a framework for incorporating Environmental Justice into the ARB's programs consistent with the directive of California State law. “Environmental justice” is defined as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. These policies apply to all communities in California but recognize that environmental justice issues have been raised more in the context of low-income and minority communities.

The Environmental Justice Polices (Policies) are intended to promote the fair treatment of all Californians and cover the full spectrum of ARB activities. Underlying these Policies is a recognition that the agency needs to engage community members in a meaningful way as it carries out its activities. People should have the best possible information about the air they breathe and what is being done to reduce unhealthful air pollution in their communities. The ARB recognizes its obligation to work closely with all communities, environmental and public health organizations, industry, business owners, other agencies, and all other interested parties to successfully implement these Policies.

The proposed regulation is consistent with the Environmental Justice Policy to reduce health risks from TACs in all communities, including those with low-income and minority populations, regardless of location. The proposed regulation would reduce diesel PM emissions from commercial harbor craft diesel-fueled engines by requiring the replacement of existing engines with certified Tier 2 or Tier 3 engines, whichever meets the U.S. EPA marine emission standards for the calendar year when compliance would be required. The proposed regulation also includes rebuild, retrofit, and testing options. The proposed regulation would provide air quality benefits for all communities depending upon the number of existing commercial harbor craft diesel fueled engines currently operating in those communities.

The proposed regulation would significantly reduce the public’s exposure to diesel PM emissions and the resulting health effects, particularly for those living in communities nearest the ports and waterways where these vessels operate. As discussed in the next section, staff’s outreach efforts included public workshops and community outreach meetings where information was provided to the public and other stakeholders regarding the benefits of the proposed regulation. These included meetings at the Ports of Los Angeles and Long Beach.

2. Public Outreach

During the development process, ARB staff proactively searched for opportunities to present information about the proposed regulation at places and times convenient to stakeholders. For example, meetings were held at times and locations that encouraged public participation. Attendees included representatives from environmental organizations, engine and diesel emission control associations, and other parties interested in commercial harbor craft diesel-fueled engines. These individuals participated both by providing data and reviewing draft regulations and by participating in open forum workshops, where staff directly addressed their concerns. Table II-6 provides information regarding meetings that were held to apprise the public about the development of the proposed regulation.

The ARB has held 12 public workshops and 3 community outreach meetings since 2001 in developing this rule, as shown in Table II-6. Over 1,000 individuals and/or companies were notified for each workshop through a series of mailings. Notices were posted to ARB's diesel risk reduction and public workshops web sites and e-mailed to subscribers of the commercial harbor craft diesel risk reduction electronic list server.

Table II-6: Workshop/Outreach Meeting Locations and Times

Date	Meeting	Type	Location
March 23, 2004	Public Workshop	Webcast	Cal/EPA Building, Sacramento
May 6, 2004	Public Workshop	Toll Free Conference Call	Cal/EPA Building, Sacramento
August 5, 2004	Public Workshop	Toll Free Conference Call	Cal/EPA Building, Sacramento
December 7, 2004	Public Workshop	Toll Free Conference Call	Cal/EPA Building, Sacramento
January 14, 2005	Community Outreach	Presentation Q&A	PCFFA Meeting, Moss Landing
January 19, 2005	Community Outreach	Conference Call Presentation Q&A	POLA PCAC AQS, Los Angeles
February 16, 2005	Public Workgroup	Conference call	Cal/EPA Building, Sacramento
May 17, 2006	Public Workshop	Toll Free Conference Call	Cal/EPA Building, Sacramento
June 28, 2006	Public Workshop	Toll Free Conference Call	Cal/EPA Building, Sacramento
July 27, 2006	Public Workshop	Toll Free Conference Call	Cal/EPA Building, Sacramento
September 12, 2006	Maritime AQ Technical Working Group	Meeting	Port of Long Beach
September 13, 2006	NESCAUM Briefing	Conference Call	Cal/EPA Building, Sacramento
September 19, 2006	Public Workshop	Toll Free Conference Call	Cal/EPA Building, Sacramento
October 27, 2006	Community Outreach	Presentation Q&A	PCFFA Meeting, Bodega Bay
February 16, 2007	Public Workshop	Toll Free Conference Call	Cal/EPA Building, Sacramento
April 24, 2007	Public Workshop	Toll Free Conference Call	Cal/EPA Building, Sacramento
June 27, 2007	Public Workshop	Toll Free Conference Call	Port of Los Angeles

In addition to the public workshops or community outreach meetings presented in Table II-6, ARB staff and management participated in numerous industry and government agency meetings over the past three years, presenting information on the Diesel Risk Reduction Plan and the Goods Movement Emission Reduction Plan, and our proposed regulatory approach for commercial harbor craft. Staff also participated in meetings of the California Air Pollution Control Officers Association (CAPCOA), where current status reports were given on the progress of the proposed regulation, and feedback from CAPCOA was incorporated into the proposed regulation.

As a way of inviting public participation and enhancing the information flow between the ARB and interested parties, staff created a diesel risk reduction program Internet web site (http://www.arb.ca.gov/harborcraft). Since that time, staff has consistently made available on the web site all related documents, including meeting presentations and draft versions of the proposed regulatory language. The web site has also provided background information on diesel PM, fact sheets, workshop and meeting notices and materials, and other diesel related information, and has served as a portal to other web sites with related information.

3. Outreach to Public Agencies

Part of the regulatory development process is the outreach to public agencies that could be impacted by the proposed regulation. For the proposed harbor craft regulation, ARB staff contacted 80 public agencies representing federal, State, county, and local governments. Agencies contacted include the U.S. Department of Commerce, the California Highway Patrol, California Department of Transportation, county sheriff's departments, ports in California, and local police and fire departments. The ARB staff received more than 60 responses to our inquiries. Based on those responses, staff sent an advisory regarding the proposed regulation to over 50 responding agencies which could be impacted by the proposed regulation.

In addition, ARB staff used information about harbor craft operated by public agencies gathered through a survey of harbor craft owner operators to develop estimates of the potential fiscal impacts of the proposed regulation on public agencies. The agencies for which ARB has data include the U.S. Department of Commerce, California Department of Transportation, ports in California, and local agencies that operate ferries. The ARB staff used the engine model year, horsepower, and annual activity data associated with more than 60 harbor craft operated by public agencies to evaluate the potential fiscal impacts on public agencies.

Outreach efforts have also included personal contacts via telephone, electronic mail, regular mail, surveys, facility visits, and individual meetings with other interested parties. These contacts have included interactions with harbor craft owners/operators, engine manufacturers, local and national trade association representatives, environmental and pollution prevention organizations, State agencies, military officials and representatives, and other federal agencies.

REFERENCES:

(ARB, 2001) California Air Resources Board. *Policies and Actions for Environmental Justice*; December 2001.

(ARB, 2004) California Air Resources Board. *ARB Statewide Commercial Harbor Craft Survey, Final Report*; March, 2004.

(EPA, 2007) U.S. Environmental Protection Agency. *Draft Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters Per Cylinder.* EPA 420-D-07-001, March, 2007.

(IMO, 1997) International Maritime Association, The Protocol of 1997 (Annex VI - Regulations for the Prevention of Air Pollution from Ships), Adoption: 26 September 1997.

III. HARBOR CRAFT INVENTORY AND EMISSIONS

This chapter provides information about commercial harbor craft operating in Regulated California Waters. "Regulated California Waters" include all California internal waters, estuarine waters, ports, and coastal waters within 24 nautical miles of the California coastline. Descriptions of the various types of harbor craft, a discussion of the types of diesel-fueled engines used in California's harbor craft, and estimates of air emissions from those vessels are presented below.

Much of the information presented in this chapter was gathered as a result of an ARB survey of commercial harbor craft owner/operators throughout California. The ARB conducted the survey to collect information about where the different types of harbor craft in the State operate, vessel activity, and engine-specific information (ARB's Statewide Commercial Harbor Craft Survey, or ARB Survey) (ARB, 2004). Owners and operators of commercial fishing vessels, charter fishing vessels, ferries, excursion vessels, tugboats, towboats, crew and supply vessels, pilot boats, work, and other types of harbor craft were sent a copy of ARB's survey in late 2002. The survey requested information about the home port, the type of vessel, if the vessel was used for commercial fishing, the type of fishery targeted, annual fuel use, information about where the vessel generally operated, and engine information (make and model of the engine, if it is a propulsion or auxiliary engine, horsepower, if repowered, annual hours of use, etc.).

The ARB Survey was sent to more than 5,000 owner/operators statewide, and ARB received more than 700 responses representing approximately 850 vessels. For the purposes of developing an estimate of emissions from commercial harbor craft, ARB staff considered and assumed the engine use information (e.g., engines size, number per vessel, operating time and fuel use) gleaned from the ARB Survey to be representative of the population of commercial harbor craft statewide. A copy of the ARB Survey is provided in Appendix D.

A. Harbor Craft Inventory, Descriptions, and Uses

The vessels that make up California's harbor craft population serve a variety of purposes and vary in size. Each category of harbor craft makes an important contribution to California's economy and well being – from fishing vessels that provide food to work boats that perform rescue missions at sea.

Table III-1 provides ARB's estimate of the numbers of the various types of harbor craft operating in California in 2004. These estimates are based on information gathered from multiple data sources. Those sources included the U.S. Coast Guard, the California Department of Fish and Game, the ARB Survey, and information submitted by the Port of Los Angeles. The ARB staff chose 2004 as the base year for the harbor craft inventory because the most complete data was available from the different sources for that year. As shown in Table III-1, ARB staff estimates that in 2004 there were approximately 4,200 harbor craft serving various industries. Staff estimates that the

2007 statewide harbor craft population is 3,750 vessels. The decline in vessel population is due to a decrease in commercial fishing vessels.

Table III-1: 2004 Statewide Population of Harbor Craft by Vessel Type

Vessel Type	Vessel Population[A]
Commercial Fishing	2,727
Charter Fishing	563
Ferries and Excursion	416
Tugboats	128
Towboats	35
Crew and Supply Boats	64
Pilot Boats	27
Work Boats	89
Other Vessels	136
Total	**4,185**

[A] Statewide numbers of harbor craft have been estimated based on the 2004 baseline harbor craft emission inventory.

The following is a brief description of each of the harbor craft vessel types list in Table III-1. We will start by describing commercial fishing vessels and the various fishing methods used in California waters.

1. Commercial Fishing Vessels

Commercial fishing vessels are diesel-fueled harbor craft dedicated to searching for and collecting fish for sale at market. Commercial fishing is the largest category of harbor craft vessels operating in California. Over 50 percent of the statewide harbor craft vessel population are commercial fishing vessels. A typical commercial fishing vessel has a single 230 horsepower (hp) propulsion engine and a single 70 hp auxiliary engine. However, commercial fishing vessel engines can vary greatly depending on the size and use of the vessel. Propulsion engines can be over 1,000 hp and auxiliary engines up to 300 hp.

Commercial fishing vessels' construction, operating characteristics (horsepower needed, average vessel speed, engine load, distance from shore, etc.) and fishing method vary with the type of fish sought. Generally, commercial fishing vessels are outfitted to be able to use several different fishing methods over the course of the fishing season. Below are descriptions of the key types of commercial fishing vessels operating in Regulated California Waters. The percentages of individual fishing methods used by commercial fishing vessels in the descriptions below are representative of the percentage of the total fishing fleet that use that fishing method, not the percentage of total time used.

a. Troller

Troller vessels are one of the more common types of commercial fishing vessels in California. The ARB Survey showed that more than 50 percent of all commercial fishing vessels utilize trolling as a commercial fishing method. (ARB, 2004) Trollers tow lines with hooks on the ends and are most often used for salmon and albacore fishing. (UC, 2007) The vessels vary greatly in size from small, hand troll skiffs to large, ocean-going troll vessels 50 feet or more in length. (ADFG, 2007)

Troller

b. Trapper

Trappers are used for setting pots or traps for catching fish, lobster, crabs, crayfish, and other similar species. These vessels were the second most common type of commercial fishing vessel reported in the ARB Survey. Approximately 25 percent of the statewide commercial fishing fleet are trappers or engage in trap fishing. Trappers come in many shapes and sizes, from smaller vessels utilizing diesel-fueled outboard motors to fish near-shore waters to seagoing vessels of 100 feet or more in length. (ADFG, 2007) Like other commercial fishing vessels, trappers are often used for other types of fishing, such as longline and gillnet.

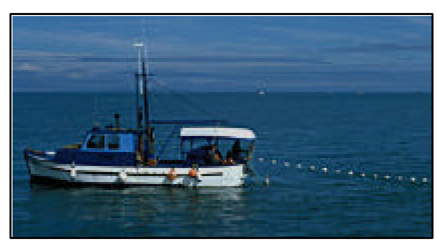
Trapper (Crabber)

c. Longliner

Longliners are used primarily to catch bottomfish, such as halibut, cod, and rockfish, and get their name from the long lines with baited hooks that are laid on the ocean floor bottom. These vessels are typically between 50 to 100 feet long and can carry 20 to 40 tons or more of iced product. (ADFG, 2007) Approximately 25 percent of commercial fishing vessels are used for longline fishing at various times through the fishing season.

d. Gillnetter

Gillnetters typically catch salmon and a few other types of Fish by setting curtain-like nets perpendicular to the direction in which the fish are traveling. (ADFG, 2007) Some gillnetter vessels also function as longliners (and vice-versa) and operate both on the ocean and on rivers. Vessel lengths vary greatly; those operating in deeper waters are typically 30 to 45 feet long. Gillnetters can comprise up to 10 percent of the commercial fishing activity in California.



Gillnetter

e. Trawler


Trawler

Not to be confused with trollers, trawlers use a commercial fishing method in which the vessel drags a cone-shaped net with a rectangular opening through the water to trap fish. (WCA, 2007) Trawlers are generally used to catch halibut and other bottomfish and make up approximately 10 percent of the commercial fishing activity in California.

f. Purse Seiner


Purse Seiner

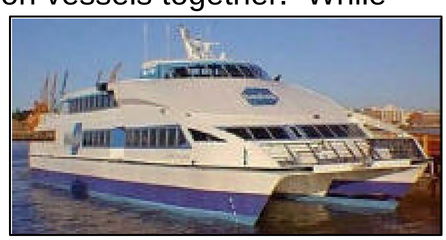
Purse seiners make their catch using a net to encircle fish, such as tuna, salmon, and sardines. While vessel lengths vary greatly, a typical purse seiner is between 40 and 60 feet long. Of the commercial fishing vessels in California, approximately 6 percent of fishing activity are associated with purse seiners.

2. <u>Charter Fishing Vessels</u>

Charter fishing vessels are similar in design to other commercial fishing vessels, except that they are used for hire by the general public. Charter fishing vessels are the second largest category of commercial harbor craft in California and make up approximately 11 percent of the statewide harbor craft population. A typical charter fishing vessel has two 400 hp propulsion engines and a single 50 hp auxiliary engine.

3. <u>Ferry/Excursion Vessels</u>

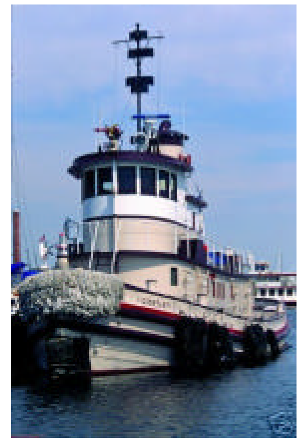
Ferries and excursion vessels are the third largest category of harbor craft in California. They make up 10 percent of the total harbor craft population. These vessels are used to transport people or property and are owned, controlled, operated, or managed for public use. The ARB Survey grouped ferries and excursion vessels together. While these vessels have certain similarities, there are a number of basic differences. Ferries are typically used to transport passengers. Excursion vessels are hired for recreation, sightseeing, and entertainment and include dinner cruises, diving trips, whale watching tours, and other similar activities. Excursion vessels typically have a more flexible schedule than ferries.


Ferry

According to our survey, most ferries and excursion vessel have two propulsion engines and one auxiliary engine. The engines on ferries are usually higher horsepower than the engines on excursion vessels. A typical ferry has two 1,100 hp propulsion engines and a single 110 hp auxiliary engine. A typical excursion vessel has two 400 hp propulsion engines and a single 80 hp auxiliary engine.

4. Tugboats

California's tugboats are a relatively small part (about 3 percent) of the overall vessel population comprising approximately 130 vessels. Tugboats are vessels used for towing (and pushing) ships or other floating structures such as barges in ports, rivers, and harbors. Tugboats generally can be divided into three groups: harbor or short haul tugboats, ocean-going or long-haul tugboats, and barge tugboats. Ocean-going tugboats have the ability to haul loads along the coastline or through the open ocean and can also be used as harbor tugboats.



Tugboat

Tugboats typically have two 1,300 hp propulsion engines and two 100 hp auxiliary engines. However, newer tugboats are being overpowered in anticipation of increases in container ship size and the ARB survey indicated that tugboat propulsion engines can be as large as 3,600 hp. Tugboats are the most active vessel category based on fuel use data. Approximately 30 percent of the total fuel use for all harbor craft operating in California is used by the tugboat fleet. (ARB, 2004)

5. Towboats

The current towboat population is estimated to be approximately 35 vessels statewide. Towboats are similar in shape and function as tugboats, the primary difference being that towboat hulls are usually rectangular and have little freeboard (the portion of the side of the hull that is above the water). A typical towboat has two 500 hp propulsion engines and a single 80 hp auxiliary engine. However, towboat propulsion engines can be as large as 1,500 hp. (ARB, 2004)

6. Crew and Supply Boats

Crew and supply boats are vessels used for carrying personnel and supplies to and from off-shore and in-harbor locations including off-shore work platforms, construction sites, and other vessels. The ARB inventory estimates that there are approximately 64 crew and supply boats operating in California. A typical crew and supply boat has three 450 hp propulsion engines and a single 80 hp auxiliary engine. (ARB, 2004)

7. Pilot Boats

Pilot vessels are designed to transport and transfer maritime pilots to and from ocean-going vessels. The ARB inventory estimates there are 24 pilot vessels working in the State. A typical pilot boat has two 400 hp propulsion engines and a single 30 hp auxiliary engine. (ARB, 2004)

8. Work Boats

Work boats comprise a wide variety of vessels that perform duties such as fire/rescue, law enforcement, hydrographic surveys, training, and construction vessels. A typical work boat has two 250 hp propulsion engines and a single 100 hp auxiliary engine. Engine sizes can vary significantly for work boats, depending on use, with propulsion engines varying from 15 to 1300 hp. (ARB, 2004)

Fire Boat

9. Other Vessels

The ARB Survey also collected information on vessels classified as “other”. These vessels do not fit in the other eight categories. For examples, other vessel types include scientific research, youth training, and specialty spill response vessels. These vessels vary greatly in size and shape, the average engine sizes from the survey indicate a single 300 hp propulsion engine a single 50 hp auxiliary engine. (ARB, 2004)

B. Marine Engines in Harbor Craft Vessels

Diesel-fueled marine engines are off-road engines marinized for use in marine environments. Marine engines are used as both propulsion (main) and auxiliary engines. Propulsion engines provide power to move a vessel through the water or direct the movement of another vessel. Auxiliary engines provide power for uses other than propulsion, such as lights, navigation and communication systems, and refrigeration.

Marine engines tend to have a much longer life than their on-shore counterparts. According to the ARB Survey, approximately 45 percent of harbor craft propulsion engines were more than 20 years old and 20 percent were more than 30 years old. Marine engines’ long life can be attributable to a number of factors including the use of in-place engine rebuilds to extend the service life of existing engines and a general practice within the industry of safety-related engine maintenance.

The diesel-fueled marine engines used in harbor craft vary in number of engines per vessel and the horsepower of the engines used. This can be seen in Table III-2. Ferries, tugboats, and towboats tend to have the highest horsepower engines in the harbor craft fleet. Commercial fishing vessels tend to have to lowest horsepower engines in the fleet.

Table III-2: Number of Engines and Average Engine Horsepower for Typical Harbor Craft

Vessel Type	Typical Number of Propulsion Engines	Average Hp: Propulsion Engine	Typical Number of Auxiliary Engines	Average Hp: Auxiliary Engine
Commercial Fishing	1	230	0	70
Charter Fishing	2	380	1	50
Ferries and Excursion	2	730	1	90
Tugboats	2	1,300	2	110
Towboats	2	500	1	80
Crew and Supply Boats	3	440	1	80
Pilot Boats	2	410	0	30
Work Boats	2	240	0	100
Other Vessels	1	280	0	56

(ARB, 2004)

Marine engines used in California harbor craft can vary greatly in size, number of cylinders, and cylinder displacement. Horsepower for these engines can range from less than 50 hp up to 5,000 hp. Generally, these marine engines have from 3 to 16 cylinders and the cylinder displacement can vary from less than 1 liter per cylinder (L/cyl) to over 10 L/cyl.

C. Marine Engine Emission Standards

As explained in Chapter II, new marine engines have been required since 1999 to meet emission standards established by U.S. EPA. The U.S. EPA marine engine emission standards have phased effective dates and emission levels depending on the engine size. Table III-3 provides a summary of the U.S. EPA marine standards by engine categories, tier level standard, standards adoption and effective dates, and the emission standard range for PM and NOx pertaining to harbor craft operating in Regulated California Waters. More detailed information regarding the standards is available in Chapter II.

Table III-3: U.S. EPA Marine Engine Standards Effective Dates and Emission Limits for Category 1 and Category 2 Engines Used in Harbor Craft

Category	Tier Level	Adoption Date	Effective Date	PM (g/bhp-hr)[A]	NOx (g/bhp-hr)[A]
1	1	IMO 1997 U.S EPA 2003	2000 2004	N/A	7.3 – 12.7[B]
	2	U.S. EPA 1999	2004-2007	0.15-0.3	5.4-5.6[E]
	3	U.S. EPA proposed 2007[C]	2009-2114	0.08-0.3	3.5-5.6[E]
	4[D]	U.S. EPA proposed 2007[C]	2017	0.03	1.3
2	1	IMO 1997 U.S EPA 2003	2000 2004	N/A	7.3 – 12.7[B]
	2	U.S. EPA 1999	2007	0.2	5.8[E]
	3	U.S. EPA proposed 2007[C]	2013	0.1	4.6[E]
	4[D]	U.S. EPA proposed 2007[C]	2016-2017	0.03	1.3

(40 CFR Part 94)

[A] Converted standards from 40 CFR 94, which are expressed in g/kW-hr, to g/bhp-hr, by the following: g/kW-hr X 0.746 = g/bhp-hr

[B] Standard is a function of engine speed, revolutions per minute (rpm). Standard=12.7 for engines with engine speed = 2000 rpm. Standard=7.3 for engines with engine speed =130 rpm. For engines between 130 and 2000 rpm, standard = $33.57 \times rpm^{-0.2}$

[C] Proposed U.S. EPA marine engine Standard per April 3, 2007, Draft Locomotive and Marine Notice of Proposed Rule Making (NPRM).

[D] Applies only to engines with maximum horsepower rating of 800 hp (600 kW) or more.

[E] NOx is NOx + total HC

The Tier 3 and Tier 4 standards listed in Table III-3 have been proposed by U.S. EPA but not yet adopted. Tier 4 standards will require aftertreatment technology to meet the emissions targets. The U.S. EPA has proposed Tier 4 standards only for engines with maximum power ratings of 800 hp and greater.

Marine diesel-fueled engines emission standards have not kept pace with the emission standards for similar land-based diesel-fueled engines. The first U.S. EPA rule regulating new marine engines was promulgated in 1999. The first tier (Tier 1) emission standard in this rule did not address PM. The standards did not become mandatory until 2004; however, engine manufacturers voluntarily complied with these standards starting in 2000.[4]

Table III-4 illustrates how the marine engine emission standards have lagged behind standards for similar land–based engines. Table III–4 compares the Tier 2 emission standards for a 600 hp off-road (land-based) engine with the Tier 2 emission standards for a 600 hp marine engine. As shown in the table, the 2002 Tier 2 emission standards for a land-based off-road engine are 25 percent more stringent for PM and about

[4] Standards were retroactive through the IMO for new engines manufactured beginning in 2000 upon the ratification of Annex VI.

10 percent more stringent for NOx compared to the 2004 Tier 2 standards currently in effect for the same horsepower marine engine.

Table III-4: Comparison of Tier 2 Emission Standards, Off-road versus Marine Engines

Engine Type	Horsepower	Effective Date	PM Standard g/bhp-hr[A]	NOx Standard g/bhp-hr[A]
Off-road	600	2002	0.15	4.8
Marine	600	2004	0.20	5.4

[A] Grams per brake horsepower-hour

The higher emission levels for marine engines have resulted in harbor craft engines becoming a significant source of air pollutant emissions in California despite the relatively small statewide population. This is particularly true when one considers coastal areas with heavy marine activities. It is estimated that emissions from harbor craft in the Bay Area Air Quality Management District are equivalent to almost 60 percent of the emissions from diesel trucks in that district.[5]

D. Estimated Emissions from Harbor Craft

The ARB staff estimated the population of and the emissions from diesel-fueled harbor craft engines operating in California waters using information from the following sources:

- 2004 ARB survey of harbor craft owner/operators,
- emission inventories developed for the ports of Los Angeles (2001) and Long Beach (2002), and
- ARB's OFFROAD model.

Baseline emission estimates of diesel PM and NOx for the year 2004 were developed along with emission projections through 2025 based on estimates of expected growth, vessel engine turnover, and vessel engine age distribution. A description of the methodology for developing the engine inventory and associated emissions and the projection for future years is provided in Appendix B.

Table III-5 provides an overview of the unregulated (Tier 0), pre-2000 emissions from marine diesel-fueled engines used in harbor craft. Generally, the older the engine is, the higher the emissions of diesel PM and NOx. Table III-5 is provided as a baseline for the purpose of comparison with the standards set by U.S. EPA.

[5] Compared to emission estimates for heavy heavy duty diesel trucks in SIP v1.06_RF980.

Table III-5: Estimated "Tier 0" or Unregulated Marine Engine Emissions

Category	Horsepower	Effective Date	PM (g/bhp-hr)[A]	NOx (g/bhp-hr)[A]
1 and 2	50 to 99	< 2000	0.32 – 0.61	4.2 – 12
	100 to 174	< 2000	0.27 – 0.55	7.6 – 13
	175 to 299	< 2000	0.27 – 0.55	7.6 - 13
	300 to 750	< 2000	0.27 – 0.53	7.6 - 13
	751 to < 5000	< 2000	0.27 – 0.53	7.6 - 13

(ARB, 2005)
[A] Grams per brake horsepower-hour

ARB staff estimates that, based on the 2004 inventory, about 80 percent of California's harbor craft engine population are Tier 0 engines with the remaining 20 percent being Tier 1 compliant. (ARB, 2004) Tier 2 standards were adopted in 1999 and became effective starting in 2004 for smaller Category 1 engines and are coming into effect during 2007 for larger Category 1 engines and all Category 2 engines. Since 2004, some of the smaller engines have been replaced with Tier 2 engines. The numbers of Tier 2 engines installed in California's harbor craft population is very small at this time.

1. Harbor Craft Vessel and Engine Populations

Table III-6 provides information about the numbers of harbor craft by vessel type and the number of diesel fueled engines (propulsion and auxiliary) associated with these vessels. As shown in Table III-6, there are approximately 8,300 diesel-fueled engines in about 4,200 harbor craft operating in Regulated California Waters. Of these engines, the majority, approximately 70 percent, are associated with fishing vessels. Engines on ferries and excursion vessels are the next largest category with about 15 percent of the engine population.

Table III-6: 2004 Populations of Vessels and Numbers of Engines by Vessel Type

Vessel Category	Numbers of Vessels	Numbers of Engines
Commercial Fishing	2,727	4,308
Charter Fishing	563	1,419
Ferries/Excursion	416	1,348
Tugboat	128	450
Towboat	35	115
Crew and Supply	64	230
Pilot	27	50
Workboats	89	158
Other	136	214
Total	**4,185**	**8,291**

ARB staff chose 2004 as the base year for the harbor craft inventory because the most complete data was available for that year. The initial reporting requirements in the proposed regulation will provide valuable information that can be used to update and improve the harbor craft emission inventory. In addition, the major California ports continue to update and improve their harbor craft emission inventories. As this information becomes available, ARB staff intends to update the statewide emissions estimate for harbor craft.

As described in Appendix B, staff projected the commercial harbor craft population for the current and future years using air districts' fleet growth rates adjusted as appropriate by other available information. Because tugboats are generally over-powered and are capable of handling larger vessels, staff assumed tugboat fleet growth to be flat throughout the future years projected. The growth rate for California's commercial fishing fleet was adjusted to represent the most recent fish landings (tons per year) data available. These data indicate that there has been a six percent per year decline in landings over the last decade. Since there is no way to accurately predict whether that trend continues indefinitely, an annual decline of six percent in the numbers of commercial fishing vessels in California's waters was assumed to continue through 2009. From 2010 on, the growth was assumed flat. This decline in commercial fishing is the major difference between the 2007 harbor craft emissions estimate and the 2004 emissions estimate.

Engine population for current and future years was estimated based on the projected vessel population, the assumption that vessels in future years would have the same number of engines (as shown in Table III-2) and same engine profiles as the vessels in the base year, along with engine attrition rates based on ARB's OFFROAD model.

2. <u>Baseline Emission Estimates for Diesel-fueled Harbor Craft (2004)</u>

Appendix B provides a detailed description of the emission estimation methodology used to estimate emissions from harbor craft operating in Regulated California Waters. To estimate California statewide commercial harbor craft emissions, staff developed emissions rates, i.e., average emissions per engine per year, for each vessel type and specific region using engine activity information collected in the ARB Survey (ARB 2004). Statewide emissions rates were determined using the engine population of each engine category in each region.

Data used for estimating harbor craft emissions include:

- Base year vessel and engine population
- Future fleet growth and engine turn over rates
- Engine hours of operation and engine load
- Zero-hour (new engine) emission factor
- Engine deterioration and other adjustments
- Spatial allocation of engines

ARB staff estimate that diesel-fueled harbor craft engines operating in California coastal and inland waters result in approximately 3.3 tons per day (tpd) of diesel PM emissions statewide and 73 tpd of NOx in 2004.

In addition, based on a range of statewide NOx to PM conversion factors of 0.3 – 0.5 g NH_4NO_3/g NOx, ARB staff estimate a secondary formation of PM2.5 nitrate from NOx emissions from diesel-fueled harbor craft engines ranges from approximately 22 to 36.6 tpd.[6] Estimates of statewide 2004 diesel PM and NOx emissions from the different harbor craft vessel types are presented in Table III-7.

Table III-7: Estimated 2004 Statewide Harbor Craft Emissions

Vessel Category	2004 Pollutant Emissions, Tons/Day			
	PM	**NOx**	**HC**	**CO**
Commercial Fishing	0.8	17.4	1.3	4.8
Charter Fishing	0.6	12.7	0.9	3.3
Ferries/Excursion	0.9	21.0	1.4	5.6
Tugboat	0.6	15.3	1.0	3.8
Towboat	0.1	3.0	0.2	0.7
Crew and Supply	0.1	1.4	0.1	0.4
Pilot	<0.1	0.4	<0.1	0.1
Workboats	<0.1	0.5	<0.1	0.1
Other	0.1	1.5	0.1	0.4
Totals	**3.3**	**73.2**	**5.0**	**19.2**

Figures III-1 and III-2 illustrate the relative shares of diesel PM and NOx emitted by each type of harbor craft. It is interesting to note that fishing vessels represent about 40 percent of the diesel PM and NOx emissions, but make up 70 percent of the harbor craft engine population. Ferries, excursion vessels, tugboats, and towboats are

[6] The conversion factor for the transformation of NO_x to NH_4NO_3 was based on an analysis of annual-average conversion factors for secondary formation of PM_{10} nitrate from NO_x emissions at a number of urban sites in California. A more detailed description of the methodology used to evaluate the conversion of NO_x to NH_4NO_3 is found in Appendix F.

responsible for about 50 percent of the diesel PM and NOx emissions, but are only 25 percent of the harbor craft engine population.

Figure III-1: 2004 Harbor Craft Diesel PM Emissions in California

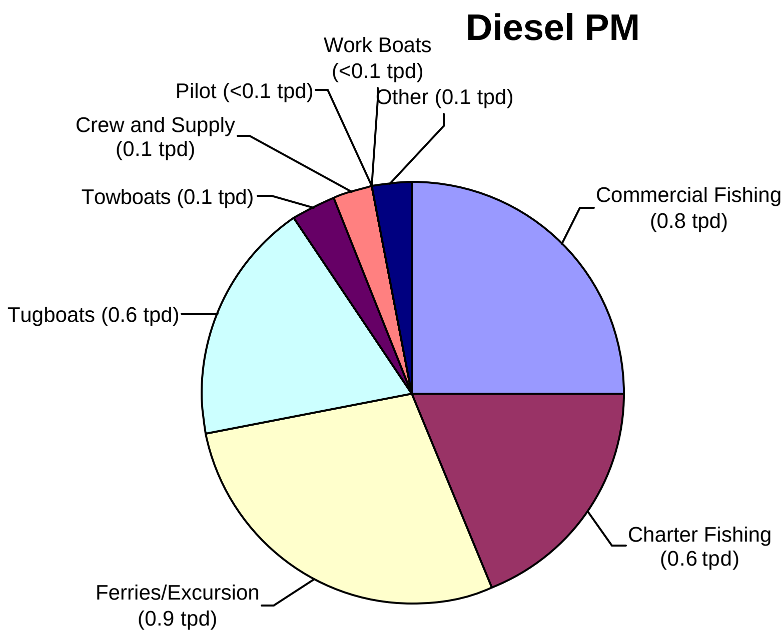
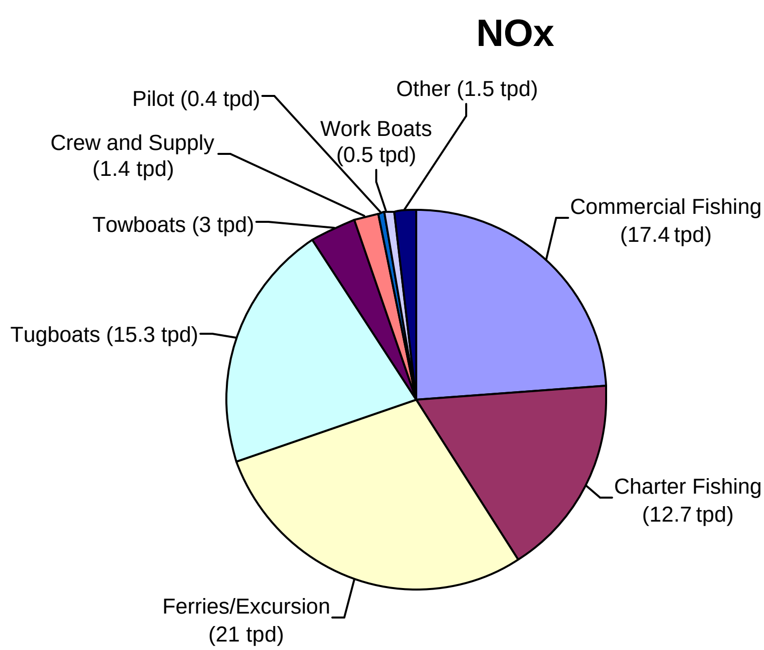


Figure III-2: 2004 Harbor Craft NOx Emissions in California



In addition to the magnitude of emissions of diesel PM and NOx from harbor craft, another important aspect is how close to shore the vessels operate. The ARB's diesel PM risk assessment for the Ports of Los Angeles and Long Beach (ARB, 2006) demonstrated that in-harbor emissions were responsible for greater health impacts than emissions that occurred outside the breakwater. Diesel PM emissions for the different vessel types are shown in Figure III-3. The emissions were broken up into three categories based on the distance from shore that the emissions occur. The three categories are in harbor (0 to 3 nm from the shore), between 3 to 24 nm from the shore, and more than 24 nm from the shore.

Figure III-3: 2004 Vessel-Specific Diesel PM Emissions by Proximity to Shore

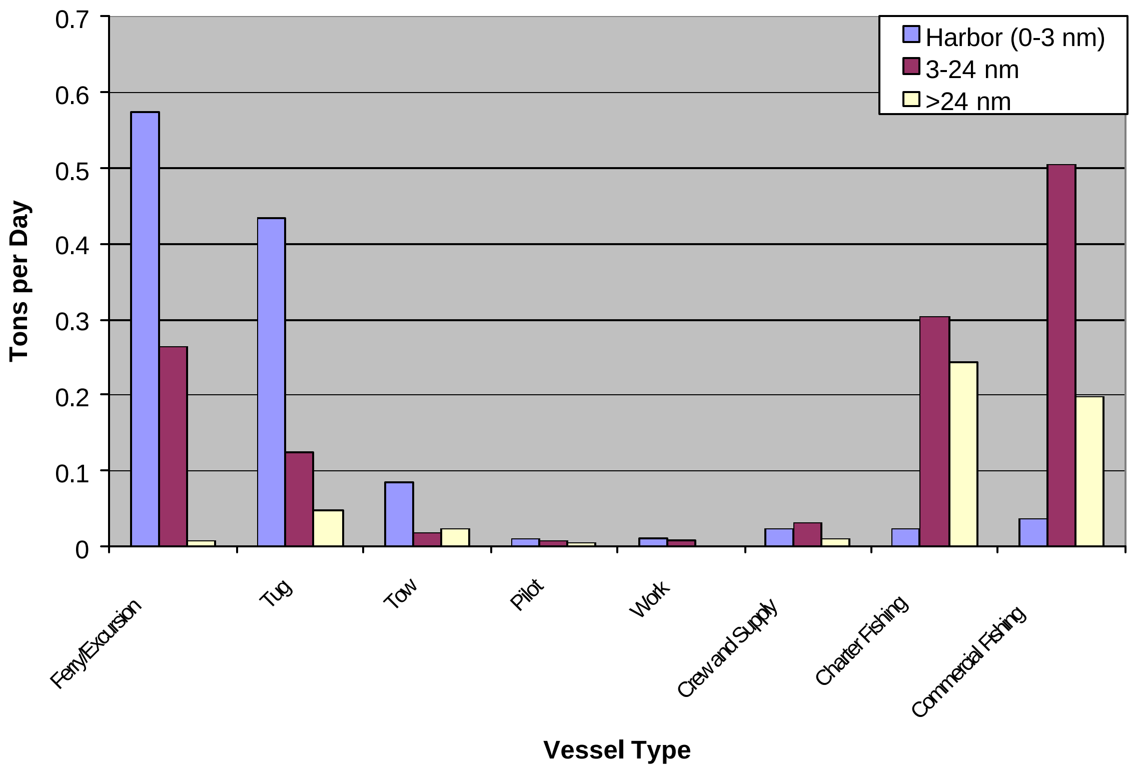


Figure III-3 shows that a majority of the ferry, excursion vessel, tugboat, and towboat emissions occur within the harbor and almost all emissions from these vessels occur within Regulated California Waters (within 24 nm). While charter and commercial fishing vessels are responsible for approximately 40 percent of statewide harbor craft emissions, only 4 percent of these emissions occur within the harbor (0-3 nm). The majority of fishing emissions occur in the 3 to 24 mile range, with 30 percent occurring more than 24 nm offshore. Thus, reducing emissions from ferries, excursion vessels, tugboats, and towboats would have a greater public health benefit than reducing emissions from all the other harbor craft categories combined.

The ARB staff also estimated district-specific emissions associated with harbor craft. The allocation of these estimates is based on the location of a vessel's home port.

Table III-8 presents a district-by-district estimate of emissions from harbor craft. Not surprisingly, the majority of harbor craft emissions are in coastal districts such as the Bay Area Air Quality Management District, the South Coast Air Quality Management District, and the San Diego County Air Pollution Control District.

Table III-8: Estimated 2004 Harbor Craft Emissions by District

District	PM (tpd)[A]	NOx (tpd)[A]
Bay Area AQMD	1.2	26.9
South Coast AQMD	0.8	18.7
San Diego County APCD	0.4	9.2
Monterey Bay Unified APCD	0.2	3.6
Ventura County APCD	0.2	3.5
Santa Barbara County APCD	0.1	2.7
North Coast Unified APCD	0.1	2.3
Yolo/Solano AQMD	0.1	1.9
San Luis Obispo County APCD	0.1	1.4
Mendocino County AQMD	0.1	1.3
Northern Sonoma County APCD	0.1	1.2
San Joaquin Valley Unified APCD	<0.1	0.8
El Dorado County APCD	<0.1	0.3
Placer County APCD	<0.1	0.3
Totals	**3.3**[B]	**73.2**[B]

[A] Emissions in tons per day (tpd)
[B] Numbers may not add up due to rounding

Since the allocations of harbor craft emissions in Table III-6 have been made based on a vessel's home port, there are districts that may be impacted by emissions from harbor craft, but have no harbor craft emissions allocated to them. As more accurate data becomes available, the harbor craft emissions allocations will be adjusted to reflect that data.

3. Projected 2015 and 2020 Emission Estimates for Harbor Craft

Future year emissions of diesel PM and NOx were developed using information provided by the districts and state regulatory agencies, and annual harbor craft growth projections developed by ARB staff for the Goods Movement Emission Reduction Plan. (ARB, 2006a) The baseline emissions include the benefits of emission control measures that were adopted before 2007, such as ARB's diesel fuel standards for commercial harbor craft and the U.S. EPA Tier 2 marine engine emission standards. The future year emissions projections include anticipated reductions due to the U.S. EPA's proposed Tier 3 and 4 engine standards. Also included are voluntary emission reduction efforts by harbor craft owner/operators prior to 2005 using Carl Moyer Program funding. The estimates do not include the projected emission reductions due to implementation of this proposed measure.

In estimating baseline future year emissions, staff assumed that engines removed from service due to natural attrition would be replaced with engines meeting the U.S. EPA marine engine standards in effect at the time of engine replacement. This assumption may result a greater projected decline in baseline emissions than might actually occur. In the absence of the proposed regulation, operators would have the option of replacing an in-use engine with an engine that does not meet the standards in effect at the time of replacement, such as a used rebuilt engine.

The resulting projected emission estimates for the years 2015 and 2020 are presented in Table III-9. With the exception of commercial fishing vessels, the growth rates used to estimate harbor craft emissions for 2015 and 2020 are the same as growth rates used in the Goods Movement Emission Reduction Plan.

Table III-9: Harbor Craft Engines Projected Year 2015 and 2020 Emission Estimates

Equipment Types	2015 Emission, Tons per Day			2020 Emission, Tons per Day		
	Number of Engines	Diesel PM	NOx	Number of Engines	Diesel PM	NOx
Commercial Fishing	3,163	0.4	7.8	3,163	0.2	5.6
Charter Fishing	1,516	0.3	8.2	1,570	0.2	6.6
Ferries/Excursion	1,448	1.0	21.1	1,508	0.7	16.0
Tugboat	450	0.5	11.2	450	0.4	8.0
Towboat	132	0.1	2.9	142	0.1	2.8
Crew and Supply	230	<0.1	0.8	225	<0.1	0.7
Pilot	52	<0.1	0.2	52	<0.1	0.2
Work	173	<0.1	0.2	182	<0.1	0.2
Other	237	<0.1	1.0	251	<0.1	0.9
Totals	**7,400**[A]	**2.3**[A]	**53.5**[A]	**7,542**[A]	**1.7**[A]	**41.1**[A]

[A] Numbers may not add up due to rounding

Data provided by the Pacific Coast Fisheries Information Network shows that commercial fishing off the coast of California has been declining for the past few years. (PACFIN, 2006) It is anticipated that the downward trend will eventually stabilize, but it is unclear when that will occur and at what level the commercial fishing vessel population will be when this occurs. Because of this, ARB staff's emission estimates for commercial fishing assume that the current decline in fishing (approximately 6 percent annually) would continue through 2009 and then remain constant into the future.

As shown in Table III-9, ARB staff is not predicting growth in the tugboat population despite projected growth in the goods delivered to California ports. The ARB staff explored the growth scenarios at ports and found several factors that play key roles in potential tugboat populations and emissions. First, vessel visits by ocean-going vessels have not been increasing from year to year. While imports of commercial goods to California's ports have been increasing, vessel sizes have concurrently increased so that the number of port visits has remained fairly constant. Tugboat companies have anticipated this increase in vessel size and have been overpowering their vessels in anticipation of handling these larger vessels. As such, the number of tugboats operating at California's ports is not expected to increase nor are the emissions from tugboats expected to grow.

As can be interpreted from the projected emission estimates in Table III-9, the overall harbor craft engine populations are relatively stable over time, with only small growth in a few categories and a reduction in commercial fishing compared to the 2004 inventory. Emissions from harbor craft are declining due to the reduction in fishing and natural attrition and the subsequent replacement with cleaner new engines. However, the rate of those reductions is not sufficient to meet the State's needs. As we will see in Chapter IV, the public health impact of the current and future emissions from harbor craft are a key contributor to potential cancer and non-cancer health impacts to Californians.

REFERENCES:

(ADFG, 2007) Gunstrom, Gary; *What Kind of Fishing Boat is That? Know Your Commercial Fishing Boats, Parts 1 and 2*; Alaska Wildlife News; http://www.wildlifenews.alaska.gov/index.cfm?adfg=wildlife_news.view_article&issue_id=25&articles_id=140; July 2007.

(ARB, 2004) California Air Resources Board. *Statewide Commercial Harbor Craft Survey Final Report*; March 2004.

(ARB, 2006) California Air Resources Board, *Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach*, April 2006

(ARB, 2006a) California Air Resources Board. *Emission Reduction Plan for Ports and Goods Movement in California*; April 2004.

(PACFIN, 2006) Pacific Coast Fisheries Information Network. Personal communication. March 2006.

(UC, 2007) Calisphere; *Trolling Gear in California – Species Caught by Trolling*; University of California Libraries; http://content.cdlib.org/xtf/view?docId=kt4h4nb078&doc.view=frames&chunk.id=d0e323&toc.depth=1&toc.id=&brand=calisphere; July 2007.

(WCA, 2007) West Coast Vancouver Island Aquatic Management Board; *Fisheries Overview by Gear Type*; http://www.westcoastaquatic.ca/fisheries_overview.htm; July 2007.

IV. HEALTH IMPACTS OF CURRENT HARBOR CRAFT EMISSIONS

This chapter discusses the potential cancer and non-cancer health impacts due to the current level of emissions from harbor craft. For the analysis of potential cancer impacts, we used earlier analyses conducted as part of the Port of Los Angeles/Long Beach Health Risk Assessment (ARB, 2006a). For non-cancer impacts, we updated work done as part of the Goods Movement Emission Reduction Plan (ARB, 2006b).

A. Potential Health Impacts of Harbor Craft Emissions

Particulate matter (PM) and NOx are the emissions of the greatest health concern from harbor craft. Particulate matter emitted from diesel-fueled engines (diesel PM) is used as the measure of the toxicity of diesel exhaust, which includes over 40 identified toxic air contaminants. The annual average concentration of diesel PM due to harbor craft emissions is used to estimate the potential cancer risk near port communities.

Non-cancer impacts are estimated based on the annual average concentration of PM. There are two sources of PM emissions from diesel-fueled harbor craft. The first source of PM is the PM directly emitted in the exhaust from diesel harbor craft engines. This is referred to as directly emitted diesel PM. The second source of PM is the PM that is formed in the atmosphere when gases emitted in the exhaust from diesel engines, primarily NOx and SOx, react to form PM. This is referred to as secondary diesel PM.

Non-cancer impacts can also occur from exposures to NOx and hydrocarbon emissions from diesel-fueled engines. NOx and hydrocarbon emissions contribute to the formation of ozone, which also has associated non-cancer health impacts.

In 1998, the Board identified PM emissions from diesel-fueled engines as a toxic air contaminant (TAC). The Board concluded that long-term occupational exposures to diesel exhaust increases the risk of developing lung cancer. The Board also concluded that a number of adverse long-term non-cancer effects have been associated with exposure, including a greater incidence of respiratory irritation and chronic bronchitis.

Over the last several years, a substantial number of epidemiologic studies have found a strong association between exposure to elevated PM levels (of which diesel PM is a subset) and adverse non-cancer health effects. (ARB, 2002; ARB, 2006b). These non-cancer health effects include premature death, increased hospitalizations for respiratory and cardiovascular causes, asthma and lower respiratory symptoms, acute bronchitis, work loss days, and minor restricted activity days. Non-cancer health effects linked to exposure to elevated levels of ozone include: premature deaths, hospital admissions for respiratory diseases, minor restricted activity days, and school absence days.

B. Estimating Potential Cancer Impacts near California Ports

As discussed earlier, harbor craft are used in and around ports throughout California, in California coastal areas and inland waterways. The diesel PM emissions from harbor craft engines contribute to background ambient levels of diesel PM. Based on the most recent emissions inventory, there are approximately 4,200 diesel-fueled harbor craft operating in California. Harbor craft are estimated to emit 3.3 tons per day (tpd) of diesel PM and 73 tpd of NOx. The increased exposure to diesel PM from diesel-fueled harbor craft engines may result in elevated cancer risks to people who live and work near California ports.

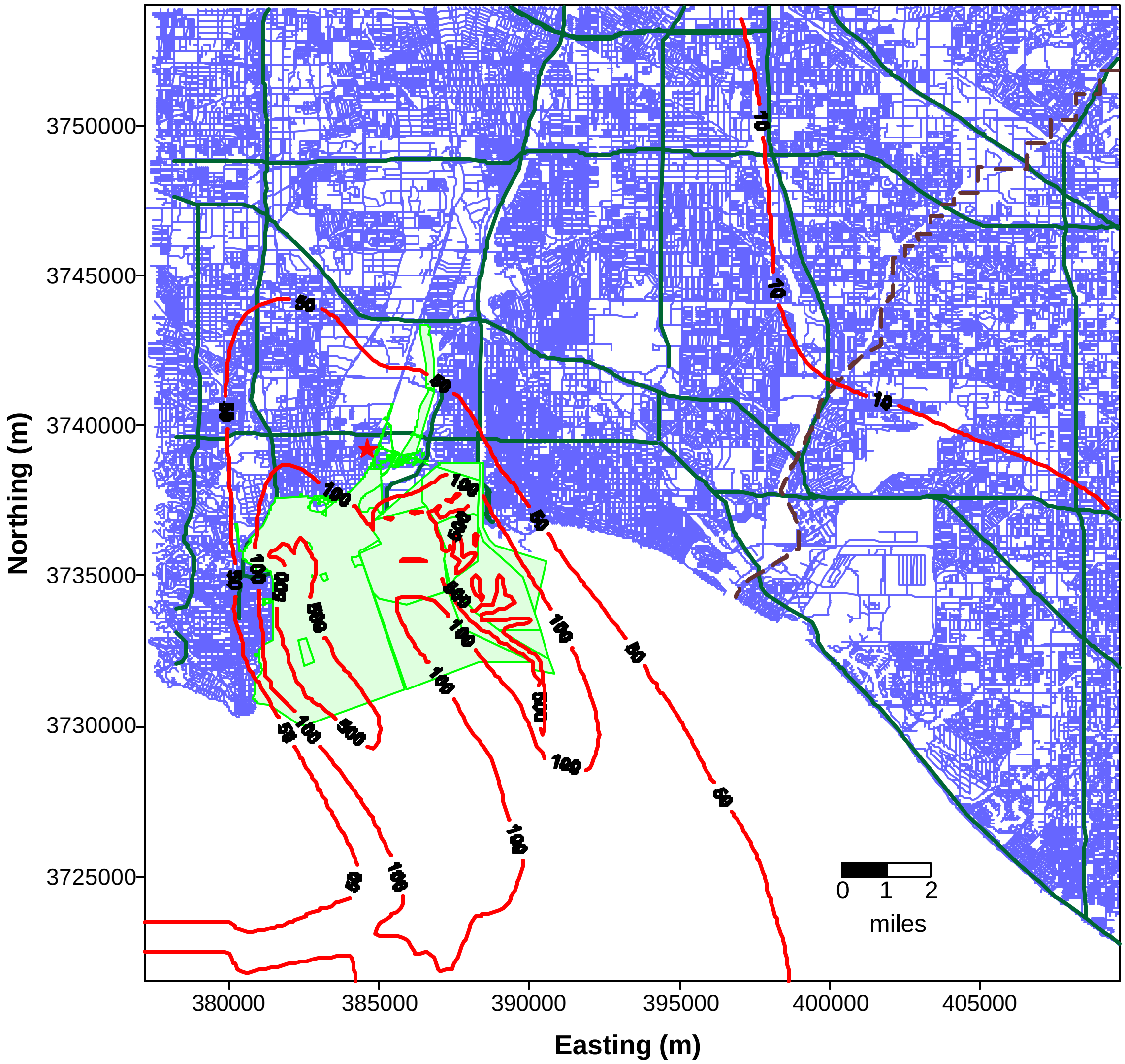
To provide a perspective on the potential cancer risk from diesel-fueled harbor craft, staff used an existing analysis from 2004 on diesel PM emissions from port related activities (including harbor craft) at the Port of Los Angles and the Port of Long Beach. (ARB, 2006a) Estimates of potential cancer risks from harbor craft activity at these two ports would represent the upper range of cancer risks, given the magnitude of harbor craft emissions in the San Pedro Bay area and the proximity of the emissions to highly urbanized areas. Qualitative estimates of the relative impact of harbor craft emissions for other areas can be estimated based on a comparison of the relative magnitude of emissions and the proximity of the emissions to urbanized areas. For example, using the district emission estimates in Table III-8, one would expect that the potential cancer risk estimate for the Bay Area would be similar to the estimate for the ports of Los Angeles and Long Beach, while the cancer risk estimates for San Diego would be about 50 percent lower.

The following section first discusses the cancer risks estimates for harbor craft operating in and around the ports of Los Angeles and Long Beach. This discussion is followed by a discussion of the methodology used to develop the cancer risk estimates.

1. Cancer Risk Estimates

The ARB staff has estimated that the emissions due to harbor craft activities may result in health risk impacts in the nearby residential areas surrounding the ports of Los Angeles and Long Beach. Figure IV-1 shows the risk isopleths for diesel PM emissions from harbor craft at the Ports of Los Angeles and Long Beach superimposed on a map that covers the ports and the nearby communities. As shown in Figure IV-1, the area in which the risks are predicted to exceed 100 in a million has been estimated to be about 750 acres. For the highest risk level of over 200 in a million, the impacted areas have been estimated to be about 20 acres. Overall, about 77 percent of the effective modeling domain of 255 square miles (excluding the port property and the surrounding ocean area) has an estimated risk level of over 10 in a million due to the emissions from harbor craft.

Figure IV-1: Estimated Diesel PM Cancer Risk from Harbor Craft Activity at the POLA and POLB (Wilmington Met Data, Urban Dispersion Coefficients, 80th Percentile Breathing Rate, Emission = 244 TPY, Modeling Domain = 20 mi x 20 mi, Resolution = 200 m x 200 m)



Using the U.S. Census Bureau's year 2000 census data, we estimated the population within the isopleth boundaries. Table IV-1 presents a summary of the area impacted and the population affected for the risk ranges of greater than 10 in a million, greater than 100 in a million, greater than 200 in a million, and greater than 500 in a million. Over 1.5 million people live in the area around the ports that has predicted cancer risks of greater than 10 in a million due to emissions of PM from harbor craft. Note that the size of the modeling domain was limited by the technical capabilities of the model. However, it is clear that a significant number of people outside the modeling domain are exposed to potential cancer risks greater than 10 in a million.

Table IV-1: Summary of Area Impacted and Population Affected by Risk Levels from Harbor Craft (emission inventory based on 2002 port calls)

Risk Level	Acres Impacted	Population Affected
Risk > 500	0	0
Risk > 200	20	5,000
Risk > 100	75	23,000
Risk > 10	125,250	1,516,000

Note: The effective modeling domain is about 255 square miles or 163,435 acres, and the total population within the domain is about 2 million. The area with predicted risks greater than 10 in a million extends beyond the modeling domain. As such, the actual acres impacted and population exposed to levels greater than 10 in a million are larger than those presented in Table III-4.

Staff adjusted the potential cancer risk for the 2002 inventory to reflect the ARB 2004 inventory for the SCAQMD. This potential risk based on the 2004 inventory provides a consistent baseline with which to compare the estimated risk using the projected controlled emissions. The adjustment to the 2004 baseline inventory increased the number of people exposed to a 10 in a million risk from 1.5 million to 1.7 million and the number of acres impacted from 125,250 to a little over 140,000..

2. Health Risk Assessment Methodology for Cancer

Because analytical tools to distinguish between ambient diesel PM emissions from harbor craft and that from other sources of diesel PM do not exist, we cannot measure the actual concentration of diesel PM from diesel-fueled harbor craft. In place of direct measurements of diesel PM, we rely on a health risk assessment process to estimate the potential cancer risks from harbor craft emissions. A health risk assessment, as defined under the Air Toxics "Hot Spots" Act, includes a comprehensive analysis of the dispersion of hazardous substances into the environment, the potential for human exposure, and a quantitative assessment of both individual and population-wide health risks associated with those levels of exposure.

To investigate the potential risks from exposures to the emissions from harbor craft, ARB staff used dispersion modeling to estimate the ambient concentration of diesel PM from harbor craft operating at the Ports of Los Angeles and Long Beach. The key variables that can impact the results of a health risk assessment for harbor craft include the diesel PM emission rate and release characteristics (magnitude, location, and time of day of the emissions), the local meteorological conditions, and the length of time a person is exposed to the emissions.

Diesel PM emissions are a function of the age and horsepower of the engine, the emissions rate of the engine, and the annual hours of operation. Older engines tend to have higher pollutant emission rates than newer engines, and the longer an engine operates, the greater the total pollutant emissions. Meteorological conditions can have a large impact on the modeled concentration of diesel PM, with higher concentrations found along the predominant wind direction and under calm wind conditions. How close a person is to the emissions plume and how long they breathe the emissions (exposure duration) are key factors in determining potential cancer risk, with longer exposure times typically resulting in higher risk.

To examine the potential cancer risks from harbor craft, ARB staff used the results of the 2004 health risk assessment for harbor craft operated at the Ports of Los Angeles and Long Beach. This analysis looked at the impacts of the 2002 estimated emissions for harbor craft operated at the two ports.

Meteorological data from Wilmington was used for this study. The Wilmington site is about one mile away from the ports, and the measurements were collected in 2001. The U.S. EPA's Industrial Source Complex Dispersion Model (ISCST3) air dispersion model was used to estimate the annual average offsite concentration of diesel PM in the area surrounding the two ports.[7] The modeling domain (study area) spans a 20 by 20 mile area, which includes both the ports, the ocean surrounding the ports, and nearby residential areas in which about 2 million people live. The land-based portion of the modeling domain, excluding the property of the ports, comprises about 65 percent of the modeling domain. A Cartesian grid receptor network (160 by 160 grids) with 200 by 200 meter resolution was used in this study. While grids within the ports were included in the receptor network, the risks within these grids were excluded from the final risk analyses. The elevation of each receptor within the modeling domain was determined from the United States Geological Service topographic data.

The potential cancer risks were estimated using standard risk assessment procedures based on the annual average concentration of diesel PM predicted by the model and a health risk factor (referred to as a cancer potency factor) that correlates cancer risk to the amount of diesel PM inhaled. The methodology used to estimate the potential cancer risks is consistent with the Tier-1 analysis presented in the Office of Environmental Health Hazard Assessment (OEHHA) Air Toxics Hot Spots Program Risk Assessment Guidelines. (OEHHA, 2002) (OEHHA, 2003) Consistent with the OEHHA guidelines, we assumed that the most impacted individual would be exposed to modeled diesel PM concentrations for 70 years. This exposure duration represents an "upper-bound" of the possible exposure duration. The potential cancer risk was estimated by multiplying the inhalation dose by the cancer potency factor (CPF) of diesel PM (1.1 milligrams per kilogram body weight-days $(mg/kg\text{-}d)^{-1}$).

C. Estimating Potential Non-Cancer Impact of Emissions from Harbor Craft Engines

To estimate the statewide potential non-cancer health impacts from harbor craft emissions, ARB staff used the same methodology used in Appendix A of the Ports and Goods Movement Emission Reduction Plan (ARB, 2006b). A substantial number of epidemiologic studies have found a strong association between exposure to ambient $PM_{2.5}$ and a number of adverse health effects (ARB, 2002). For this report, ARB staff

[7] The U.S. EPA has promulgated the AERMOD model as the preferred air dispersion model and ISCST3 had been phased out of use by November 2006. The ARB's estimates of potential health risk associated with emissions of diesel PM at the ports of Los Angeles and Long Beach was completed in 2005.

quantified seven non-cancer health impacts associated with the change in exposures to the diesel PM emissions. Since diesel PM is a constituent of ambient $PM_{2.5}$, using the epidemiologic study results to quantify diesel PM health effects is reasonable. The following section first discusses the statewide non-cancer risks estimates for harbor craft. This is followed by a discussion of the methodology used to develop the non-cancer risk estimates.

1. Non-Cancer Risk Estimates

Staff estimates that exposures to direct and secondary diesel PM emissions from harbor craft can be associated with about 90 premature deaths per year. Approximately half of these premature deaths are due to direct diesel PM and half from secondary diesel PM. All of these estimates are rounded to the tens digit.

Using the 2004 statewide estimate of directly emitted diesel PM emissions (3.3 tons per day) and the association between ambient PM exposure and mortality derived from Pope et al. (2002), we estimate approximately 50 premature deaths (10 to 80, 95 percent confidence interval (95% CI)) (for ages 30 and older) per year statewide can be associated with uncontrolled, directly emitted diesel PM from harbor craft.

Using the 2004 statewide estimate of NOx emissions from harbor craft and the relationship of NOx/nitrate to PM-mortality discussed below, we estimated approximately 50 (10 to 80, 95% CI) premature deaths (for ages 30 and older) per year statewide can be associated with uncontrolled, secondary diesel PM from harbor craft.

In addition to PM-mortality, we estimate that the 2004 estimated emissions (directly emitted and secondary sources) from harbor craft will result in the following non-cancer health impacts:

- 20 hospital admissions due to respiratory causes (10 – 30, 95% CI)
- 40 hospital admissions due to cardiovascular causes (20 – 60, 95% CI)
- 2,400 cases of asthma-related and other lower respiratory symptoms (940 – 3,900, 95% CI)
- 200 cases of acute bronchitis (0 – 430, 95% CI)
- 16,000 work loss days (13,000 to 18,000, 95% CI)
- 90,000 minor restricted activity days (74,000 to 110,000, 95% CI)

2. Non-Cancer Health Effects Methodology

a. Primary Diesel PM

Lloyd and Cackette (2001) estimated that, based on the Krewski et al. (2000) study of the American Cancer Society (ACS) cohort, a statewide population-weighted average diesel $PM_{2.5}$ exposure in the year 2000 of $1.8\,\mu g/m^3$ can be associated with a mean estimate of 1,985 premature deaths per year in California. (Lloyd/Cackette, 2001). In 2002, Pope et al. published new findings with the same ACS cohort based on a longer follow-up time and improved statistical modeling techniques. (Pope et al., 2002) Consistent with U.S. EPA (EPA, 2004), ARB has been using the new PM-mortality relationship from Pope et al. since the adoption of the Ports and Goods Movement Emission Reduction Plan. Based on Pope et al. (2002), a statewide population-weighted average diesel $PM_{2.5}$ exposure of 1.8 $\mu g/m^3$ can be associated with a mean estimate of 2,200 premature deaths per year in California, about 10% higher than previous estimates based on Krewski et al. (2000). The diesel $PM_{2.5}$ emissions corresponding to the diesel $PM_{2.5}$ concentration of 1.8 $\mu g/m^3$ is 36,000 tons for the year 2000 based on the emission inventory developed for this rule.

Using this information, we estimate that reducing 17 tons per year of diesel $PM_{2.5}$ emissions statewide would result in one fewer premature death. This statewide factor is derived by dividing 36,000 tons of diesel PM by 2,168 deaths (unrounded number of deaths described above). Although a single statewide factor (tons per death) is discussed in this example, staff actually developed basin-specific factors for the health impacts assessment of emissions from commercial harbor craft. These basin-specific factors were developed using basin-specific diesel PM concentrations and emissions for the year 2000. The statewide average of the basin-specific factors is somewhat lower than the statewide factor.

After adjusting for population changes between 2004 and 2000 and adjusting for lower on-shore impacts from emissions released off-shore, staff estimates that 590 tons of emissions from commercial harbor craft for the year 2004 are associated with approximately 50 annual deaths (10 – 80, 95% CI).[8] Estimates of other health impacts, such as hospitalizations and asthma symptoms, were calculated using basin-specific factors developed from other health studies. Details on the methodology used to calculate these estimates, including the adjustment for off-shore PM emissions in the 3 to 24 nautical mile domain, can be found in Appendix A of the Emission Reduction Plan for Ports and Goods Movement in California (ARB, 2006b).

b. <u>Secondary Diesel PM</u>

In addition to directly emitted PM, diesel exhaust contains NOx, which is a precursor to nitrates, a secondary diesel-related PM formed in the atmosphere. Lloyd and Cackette (2001) estimated that secondary diesel $PM_{2.5}$ exposures from NOx emissions can lead to additional health impacts beyond those associated with directly emitted diesel $PM_{2.5}$. (Lloyd and Cackette, 2001). To quantify such impacts, staff developed population-weighted nitrate concentrations for each air basin using data not only from the statewide routine monitoring network, which was used in Lloyd and Cackette (2001), but also from special monitoring programs such as IMPROVE and Children's Health Study (CHS) in the year 1998. The IMPROVE network provided additional information in the rural

[8] To account for the differing impact of diesel PM emission from off-shore sources, CARB staff developed a South Coast and a statewide diesel PM emissions impact adjustment factor. For the South Coast, the adjustment factor for ship diesel PM emissions release off-shore was estimated to be 0.1, based on dispersion modeling. For the rest of the state, the adjustment factor was estimated to be 0.25.

areas, while the CHS added more data to southern California. Staff calculated the health impacts resulting from exposure to these concentrations and then associated the impacts with the basin-specific NOx emissions to develop basin-specific factors (tons per death). Using a similar approach as that for primary diesel PM and adjusting for population changes between 2004 and 1998 and adjusting for NOx to nitrate conversion, staff estimates that 18,000 tons of NOx emissions from commercial harbor craft in year 2004 are associated with an estimated 50 annual premature deaths (10 to 80, 95% CI). Other health effects were also estimated as outlined above.

D. Assumptions and Limitations of Health Impacts Assessment

Several assumptions were used in quantifying the health effects of PM exposure. They include the selection and applicability of the concentration-response functions, exposure assessment, and baseline incidence rates. These are briefly described below.

•For premature death, calculations were based on the concentration-response function of Pope et al. (2002). The ARB staff assumed that the concentration-response function for premature death in California is comparable to that developed by Pope and colleagues. This is supported by other studies (Dominici et al., 2005; Franklin et al., 2007) in California showing an association between $PM_{2.5}$ exposure and premature death that is similar to that reported by Pope et al. (2002). In addition, the Pope et al. (2002) study included subjects in several metropolitan areas of California. The U.S. EPA has been using the Pope et al. (2002) study for its regulatory impact analyses since 2004. For other health endpoints, the selection of the concentration-response functions was based on the most recent and relevant scientific literature. Details are in the Emission Reduction Plan for Ports and Goods Movement in California (ARB, 2006b).

•The ARB staff assumed the model-predicted diesel PM exposure estimates published in the report titled "Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant" (ARB, 1998) could be applied to the entire population within each basin. That is, the entire population within the basin was assumed to be exposed uniformly to modeled concentration, an assumption typical of this type of assessment.

•The ARB staff assumed the baseline incidence rate for each health endpoint was uniform across each county, and in many cases across each basin. This assumption is consistent with methods used by the U.S. EPA for its regulatory impact assessment, and the incidence rates match those used by U.S. EPA.

•Although the analysis illustrates that reduction in diesel PM exposure would confer health benefits to people living in California, we did not provide estimates for all endpoints for which there are concentration response functions available. Health effects such as myocardial infarction (heart attack), chronic bronchitis, and onset of asthma were unquantified due to the potential overlap with the quantified effects such as lower respiratory symptoms and hospitalizations. In addition, estimates of the effects of PM on low birth weight and reduced lung function growth in children are not presented. While these endpoints are significant in an assessment of the public health impacts of diesel exhaust emissions, there are currently few published investigations on these topics, and the results of the available studies are not entirely consistent. (ARB, 2006). In summary, because only a subset of the total number of health outcomes is considered here, the estimates should be considered an underestimate of the total public health impact of diesel PM exposure.

REFERENCES:

(ARB, 1998) Air Resources Board. *Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant*, Appendix III, Part A, Exposure Assessment, April 1998.

(ARB, 2002) California Air Resources Board and Office of Environmental Health Hazard Assessment. *Staff Report: Public Hearing to Consider Amendments to the Ambient Air Quality Standards for Particulate Matter and Sulfates*, 2002. http://www.arb.ca.gov/research/aaqs/std-rs/pm-final/pm-final.htm;

(ARB, 2006a) California Air Resources Board. *Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach*, April 2006.

(ARB, 2006b) California Air Resources Board. *Emission Reduction Plan for Ports and Goods Movement*, 2006. http://www.arb.ca.gov/planning/gmerp/gmerp.htm

(Dominici et al., 2005) *Revised analyses of the National Morbidity, Mortality, and Air Pollution Study: mortality among residents of 90 cities*. J Toxicol Environ Health A. Vol. 68(13-14):1071-92.

(EPA, 2004) United States Environmental Protection Agency. *United States Environmental Protection Agency, Assessment and Standards Division, Office of Transportation and Air Quality, Final Regulatory Impact Analysis: Control of Emissions from Nonroad Diesel Engines*. EPA420-R-04-007. CD-ROM. Research Triangle Park, North Carolina, May 2004. http://www.epa.gov/nonroad-diesel/2004fr/420r04007j.pdf

(Franklin et al., 2007) *Association between PM2.5 and all-cause and specific-cause mortality in 27 US communities*. J Expo Sci Environ Epidemiol. Vol. 17: 279-287.

(Krewski et al., 2000) Krewski D.; Burnett R.; Goldberg M.; Hoover K.; Stemiatychi J.; Jerrett M.; Abrahamovicz M.; White W. *Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality*, Health Effects Institute, Cambridge, Massachusetts; 2000. http://es.epa.gov/ncer/science/pm/hei/Rean-ExecSumm.pdf

(Lloyd /Cackette, 2001) Lloyd, A.C.; Cackette, T.A.; *Diesel Engines: Environmental Impact and Control*; J Air Waste Manage. Assoc. 2001, 51: 809-847, 2001. http://www.arb.ca.gov/research/seminars/lloyd/AWMA2001/JAWMADieselCriticalReview.pdf

(OEHHA, 2002) Office of Environmental Health Hazard Assessment. *The Air Toxics Hot Spot Program Risk Assessment Guidelines: Part II-Technical Support Document for Describing Available Cancer Potency Factors*; 2002.

(OEHHA, 2003) Office of Environmental Health Hazard Assessment. *Air Toxics Hot Spots Program Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*; 2003.

(Pope, et. al., 2002) Pope CA 3rd, Burnett RT, Thun MJ, Calle EE, Krewski D, Ito K, Thurston GD. *Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution*. Journal of the American Medical Association. Vol. 287 (9): 1132-41, 2002.

V. PROPOSED CONTROL MEASURE

In this chapter, we provide a plain English discussion of the key requirements of the proposed regulation for diesel engines on commercial harbor craft. This chapter begins with a general summary of the regulation and the approach taken in developing the requirements in the proposal. The remainder of the chapter follows the structure of the proposed regulation and provides an explanation of each major requirement of the proposal. This chapter is intended to satisfy the requirements of Government Code section 11343.2, which requires that a "plain English" summary of the regulation be made available to the public. The proposed regulation for commercial harbor craft is included in Appendix A.

A. Summary of the Proposed Regulation

The proposed regulation is designed to reduce diesel particulate matter (PM) and oxides of nitrogen (NOx) emissions from commercial harbor craft. Emission reductions are achieved by establishing requirements for both new and in-use harbor craft. These requirements apply to any person who sells, supplies, offers for sale, purchases, owns, operates, leases, charters, or rents any new or in-use commercial diesel-fueled harbor craft that operates in California inland and coastal waters.

For new harbor craft, the proposed regulation requires the diesel engines on-board harbor craft to meet the U.S. EPA marine emission standards in effect on the date of vessel acquisition. Because ferries are a large source of emissions, operate near urban centers, and carry passengers, more stringent requirements are proposed for new ferries. Under the proposed regulation, new ferries, in addition to installing a new engine, are required to install an aftertreatment system that represents Best Available Control Technology (BACT).

Emission reductions from in-use ferries, excursion vessels, tugboats, and towboats would be achieved with the current proposal by requiring the accelerated introduction of cleaner diesel engines. As discussed in more detail in the next section, several compliance options are available to provide flexibility and reflect the diversity of diesel engines and vessel configurations currently in-use.

The proposed compliance schedule for in-use engines is based on the engine model year and hours of operation and is designed to focus on the oldest, highest use engines first. Two separate compliance timelines are proposed; one for vessels with their home port in the SCAQMD and another for vessels with their home port outside the SCAQMD. At this time, these in-use requirements only apply to ferries, excursion vessels, tugboats, and towboats. Diesel engines on in-use ferries, excursion vessels, tugboats, and towboats comprise approximately 25 percent of the harbor craft engines in the State, yet emit more than 50 percent of the diesel PM emissions. These vessel types also work close to shore, operating approximately 65 percent of the time in and around the harbor.

In addition, the proposed regulation includes requirements for monitoring, recordkeeping, and reporting. These requirements will allow staff to monitor the implementation of the regulation and provide more accurate estimates of the engine population and the associated pollution reductions

B. Discussion of the Proposed Regulation

1. Purpose

The purpose of the proposed regulation for commercial harbor craft is to reduce diesel PM and NOx from diesel-fueled propulsion and auxiliary engines on commercial harbor craft that operate in California inland and coastal waters. This regulation helps to implement the Goods Movement Emission Reduction Plan (GMERP) adopted by the Air Resources Board in April 2006. The GMERP is a comprehensive plan that identifies aggressive measures to reduce emissions and the associated health risk from ports and the movement of goods in California. This regulation will also assist in making progress toward meeting the State and federal ambient air quality standards for PM2.5 and ozone and help to fulfill State Implementation Plan emission reduction goals.

2. Applicability

This section explains who must comply with the proposed regulation. Except for the exemptions described below, the proposed regulation would apply to anyone who sells, supplies, offers for sale, purchases, owns, operates, leases, charters, or rents any new or in-use diesel fueled harbor craft that operates in "Regulated California Waters". "Regulated California Waters" are defined in the proposed regulation and include all California internal waters; estuarine waters, ports, and coastal waters within 24 nautical miles of the California coastline.

To ensure there are no conflicts with existing regulations, this section also clarifies how this regulation relates to other regulations that could potentially apply to harbor craft engines. Under the proposal, the regulation for diesel engines on harbor craft would coordinate any requirements in existing regulations for portable engines (sections 93116-93116.5, title 17, California Code of Regulation (CCR)) and off-road compression engines (sections 2420-2427, title 13, CCR) for all engines on the vessel that are permanently affixed to the vessel. For example, barge vessels in the State that currently have their engines participating in the ARB Portable Engine Registration Program (PERP) or a similar local air district program can continue with that program. On the other hand, barge vessels with engines that are permanently affixed to the vessel and that are not in the PERP or similar local air district program on or before January 1, 2009, would need to comply with this proposed regulation. Permanently affixed means that the engine, its fueling system, or its exhaust system is welded to the vessel or physically connected to the vessel or other vessel system such that the engine cannot be easily removed to be used in another application without modifying the engine.

This section also specifies that the proposed regulation applies to ocean-going tugboats, and towboats as well as any tugboats or towboats pulling, pushing or hauling alongside tank vessels or tank barges. In addition, the proposed regulation includes language clarifying that the proposal does not change any applicable U.S. Coast Guard regulations or other applicable State or federal regulations and that vessel owners and operators are responsible for ensuring that they meet all applicable U.S. Coast Guard, State, and federal regulations.

3. Exemptions

The proposed regulation includes several exemptions that specify vessels that are exempt from the regulation due to safety or operational concerns, or because they are already addressed under separate regulations. The following vessels are proposed to be exempt from all the requirements in the regulation including the requirements for new and in-use harbor craft and the monitoring and reporting requirements:

- Vessels traversing California coastal waters without stopping and without entering any California inland waterway or port, except in limited situations such as when the vessel is in distress or must stop to comply with U.S. Coast Guard regulations.
- Recreational vessels that are operated primarily for pleasure. Recreational vessels are currently regulated under title 40, California Code of Regulations (CCR), section 94.
- Ocean-going vessels, except ocean-going tugboats and towboats. Ocean-going vessels are subject to requirements in title 13, CCR, sections 2299.1 and 93118.
- Vessel engines not permanently affixed to the vessel that are currently registered with the ARB's Portable Engine Registration Program (PERP) (title 13, CCR, sections 2450 through 2465) and vessel engines not permanently affixed to the vessel that are registered with PERP on or after January 1, 2009. .
- Military tactical support vessels. These vessels must be used on a consistent basis for military operations globally and are exempt for homeland security reasons.
- All U.S. Coast Guard vessels. These vessels must be used for search and rescue operations, maritime law enforcement, port security and military readiness and are exempt for homeland security reasons.
- Temporary emergency rescue/recovery vessels that are not ported in California but are brought into California to help in an emergency rescue or recovery operations provided that it returns to its home port at the conclusion of the emergency operations.

Three types of vessels are proposed to be exempt from the in-use engine compliance requirements, but would be subject to the monitoring, reporting, and recordkeeping requirements of the proposed regulation: These vessels include historic vessels, temporary replacement vessels, and vessels to be retired:

- Vessels registered with the National Park Service (NPS) as "historic." Based on the NPS listing of all the historic vessels in the United States, California has approximately 12 registered historic vessels that may be considered harbor craft. Requiring engine replacement could impact their historic significance. One example of a historic vessel is the 1907 Hercules tugboat in San Francisco.
- Vessels that have homeports outside of California and that are brought into California to perform the work of a California vessel while that vessel is taken out of service for maintenance or repair are exempt provided that the temporary replacement vessel is used for less than 12 months. This exemption was requested by vessel fleet owners/operators with vessels both within California and in other locations and would allow them to use their own vessels from outside the State for temporary replacement of out-of-service vessels. This exemption requires the approval of the Executive Officer.
- California vessels that have homeports outside of the SCAQMD and that are brought into SCAQMD to perform the work of an SCAQMD vessel while that vessel is taken out of service for maintenance or repair are exempt from the SCAQMD engine compliance schedule, but must comply with the statewide schedule. The replacement time must be less than 12 months. The California Department of Transportation (Caltrans) requested this exemption. Caltrans operates ferries and work boats in both the SCAQMD and Bay Area and must occasionally bring a vessel from one area to the other to replace an out-of-service vessel. This exemption requires the approval of the Executive Officer.
- Engines on a vessel that is scheduled to be retired within one year of the engines' compliance date are exempt from the in-use compliance requirements of this regulation. However, if the vessel is not retired as scheduled, the engine would be in violation of this proposed regulation each day past the scheduled retirement date or the compliance date, whichever is later,

An exemption from the in-use engine performance standards for low-use engines on a ferry, excursion vessel, tugboat, or towboat is also provided. A low-use engine is an engine that operates for less than 300 total annual hours of operation. In the event the engine operates for more than 300 hours in any given calendar year, the engine would be subject to the engine compliance requirements.

Additionally, engines with less than a 50 hp maximum horsepower rating would be exempt from the in-use engine requirements for administrative reasons and because of their minimal emissions impact.

4. <u>Definitions</u>

The proposed regulation provides definitions of all terms that are not self-explanatory or have specific meaning within the context of the proposed regulation. There are over 70 definitions to help clarify and enforce the regulation requirements. Most of the definitions listed in subsection (d) of the proposed regulation were developed by staff with input from the public during workshops and workgroup meetings. Staff working on this regulation also coordinated with other ARB staff working on other diesel PM regulations to provide consistency where it was practical. Below, we discuss some of the key definitions.

Auxiliary Engine – auxiliary engines provide power for uses other than propulsion. Auxiliary engines are used for such as lights, navigation and communication systems, refrigeration, pumping fluids, dredging, and operating cranes.

Harbor Craft – any private, commercial, government, or military marine vessel including, but not limited to, fishing vessels, passenger ferries, excursion vessels, tugboats, towboats, ocean-going tugboats and towboats, push-boats, crew vessels, work boats, pilot vessels, supply boats, fishing vessels, research vessels, United States Coast Guard vessels, hovercraft, emergency response harbor craft, and barge vessels that do not otherwise meet the definition of ocean-going vessels or recreational vessels.

Date of Acquisition – for a vessel engine subject to this regulation for Harbor Craft, the date of purchase as defined by the date shown on the front of the cashed check, the date of the financial transaction, or the date on the engine purchasing agreement, whichever is earliest. Commercial harbor craft are generally built to an customer's specifications. Consequently, the date of the purchasing agreement would generally occur before the vessel is built.

Homeport – the port in which a vessel is registered or permanently based.

In-Use Engine – an engine that is not a new engine. This is generally an engine that has been transferred to an owner or operator or has been put into service.

In-Use Harbor Craft – a harbor craft that is not a new harbor craft. This is generally a harbor craft that has been transferred to an owner or operator or has been put into service.

New Harbor Craft – a harbor craft built, or for which the keel was laid, on or after January 1, 2009 and which has never been transferred to an owner or operator. In cases where the equitable or legal title to the harbor craft is not transferred to an owner or operator until after the harbor craft is placed into service, then the harbor craft will no longer be new after it is placed into service. Being placed into service means that the harbor craft is used for its functional purposes.

New Harbor Craft Engine – an engine manufactured or imported on or after January 1, 2009 and which has never been transferred to an owner or operator. In cases where the equitable or legal title to the engine is not transferred to an owner or operator until after the engine is placed into service, then the engine will no longer be new after it is placed into service. Being placed into service means that the engine is used for its functional purposes.

Temporary Replacement Vessel – a vessel whose homeport is not within California and is brought into California to be used in California for no longer than 12 months to perform the work of a California vessel that was in service and has been temporarily taken out of service.

Temporary Replacement Vessel (SCAQMD) – a vessel whose homeport is not within the SCAQMD and is brought into the SCAQMD to be used in the SCAQMD for no longer than 12 months to perform the work of a SCAQMD vessel that was in service and has been temporarily taken out of service.

5. Requirements

As mentioned earlier, the proposed regulation includes requirements for new and in-use harbor craft. Some requirements apply to all harbor craft, regardless of use and others apply to specific types of harbor-craft. For ease of explanation, the discussion on the requirements below does not follow the order of the regulation. Rather, we have categorized the requirements discussion into three subtopics: Requirements for All Harbor Craft, Requirements for Newly Acquired Harbor Craft, and Operational Requirements for In-Use Ferries, Excursion Vessels, Tugboats, and Towboats.

a. Requirements for All Harbor Craft

There are two key requirements in the regulation that apply to all harbor craft. These include a requirement for harbor craft to purchase only CARB diesel fuel or an approved alternative diesel fuel and mandatory monitoring, reporting, and recordkeeping requirements.

(i) Fuel Use Requirement

The proposal's fuel use requirement is complementary to title 13, CCR, section 2299, which requires that the non-vehicular diesel fuel sold for use in harbor craft meet the same requirements as those for California on-road diesel fuel as specified in title 13, CCR, sections 2281, 2282, and 2284. The Board adopted this regulatory section on November 18, 2004. Therefore, the fuel sellers are required to sell only fuel that meets 13 CCR §2299. The proposed regulation would complement the existing fuel regulation by applying to the vessel owners and operators, rather than fuel sellers, by requiring owners and operators to fuel their vessels only with fuel that meets the requirements for California on-road diesel.

This requirement also allows the use of an approved alternative diesel fuel. Examples of alternative fuels that could be used are biodiesel, biodiesel blends, Fischer-Tropsch fuel, emulsions of water in diesel fuel, and fuels with an additive. This provision would also allow alternative diesel fuels and CARB diesel fuel used with a fuel additive that meet the requirements of the ARB Verification Procedure.

(ii) Monitoring, Reporting, and Recordkeeping Requirements

Owners and operators of harbor craft operating in Regulated California Waters would be required to keep records for each vessel and install a non-resettable hour meter on each engine. All owners and operators of harbor craft would be required to submit an initial report to the ARB by February 28, 2009. The initial reporting would provide ARB staff with information including owner/operator contact, vessel, emission control system (if applicable), and engine information, including annual hours operated and location. At the time of initial reporting, ferry, excursion, tugboat, and towboat owners/operators would also be required to specify how they plan to comply with the proposed regulation's in-use engine requirements. Vessel owners/operators would need to keep a copy of the initial reporting form and the yearly records on the vessel or in a central dockside location to be made available upon request of the ARB enforcement staff. These records include information similar to that required for the initial reporting but also include maintenance records.

Additional reporting would be required if there is a change of ownership, a change of hours of operation, upon the purchase of new vessels or engines, and upon compliance with the in-use engine requirements. These reporting requirements would assist ARB in enforcing the regulation as well as provide information for the engine and emissions inventory for the development of future measures.

Historically, harbor craft engines have not been subject to statewide or local air district permitting or registration programs. As a result, limited data on the marine engines used aboard harbor craft is available. The mandatory reporting required by the proposed regulation would provide more complete information on California's harbor craft fleet for both implementing the current regulation and developing any further regulatory requirements.

b. <u>Newly Acquired Harbor Craft Vessels and Engines</u>

The proposed regulation includes requirements regarding the acquisition of diesel engines for in-use harbor craft and the acquisition of both new and in-use harbor craft. These requirements apply to all types of commercial harbor craft. However, there are additional conditions specifically for new ferries. All of these requirements are effective for acquisition dates of January 1, 2009 or later.

(i) Acquisition of Engines for All In-Use Harbor Craft

Newly acquired engines for all in-use harbor craft would be required to meet the U.S. EPA marine emission standard in effect at the time the vessel owner acquires the engine. This provision assures that as older engines on in-use vessels are retired they are replaced with the cleanest engine available, either Tier 2 or Tier 3. These new engines will be both cleaner and more fuel efficient than the engines that they replace.

The one exception to this is if the newly acquired engine was manufactured prior to implementation of new marine engine emission standards and is acquired by the vessel owner or operator no later than 6 months after the implementation date of the new marine standard. This allows engine retailers 6 months to sell in-stock engines after new standards become effective.

Owners/operators may elect to install a Tier 3 engine on an in-use vessel as a replacement engine after Tier 4 marine standards come into effect. Tier 4 standards will require the integration of exhaust aftertreatment into the engine design, making these engines larger and heavier. These larger heavier Tier 4 engines may not be practical for engine replacements.

(ii) Acquisition of In–use Harbor Craft Vessels

Newly acquired in-use vessels would be subject to the proposed regulation for both in-State and out-of-State purchases. A newly acquired in-use vessel that has been sold to a California party would have to comply with the non-resettable hour meter and reporting and recordkeeping requirements. If this vessel is a ferry, excursion vessel, tugboat, or towboat, the compliance schedule in Tables V-3 or V-4 would apply.

(iii) New Harbor Craft

The engines on all new harbor craft vessels will be required to meet the U.S. EPA marine emission standard in effect at the time of the vessel is acquired.

(iv) New Ferries

Propulsion engines on new ferries would be required to be even cleaner than the Tier 2 or Tier 3 standards require. The propulsion engines on all new ferries, with the capacity of more than 75 passengers, acquired after January 1, 2009, will be required to install control technology that represents BACT in addition to an engine that meets the Tier 2 or Tier 3 U.S. EPA marine engine standard, as applicable, in effect at the time of vessel acquisition. Ferry vessels can also comply with the proposed regulation by installing Tier 4 propulsion engines. The additional emission reductions are needed from this harbor craft vessel type because of the high load, high emissions, proximity to high population centers, and passenger exposure.

The proposed regulation outlines an application and approval process for owners or operators acquiring new ferries to follow to obtain approval for the proposed BACT that they propose to include in the ferry design. The process outlined includes time lines for determination of application completeness and approval and defines the information required in the application.

c. Operational Requirements for In-Use Ferries, Excursion Vessels, Tugboats, and Towboats

Commercial harbor craft in California comprise a wide range of vessel types and engines. Many of the engines installed in these vessels are older and unregulated. As ARB staff studied the data and worked with several owner/operators, it became apparent that not all harbor craft in California could be addressed with one regulation or one regulatory compliance option. Therefore, the focus of this proposed regulation is ferries, excursion vessels, tugboats, and towboats with multiple compliance options for these selected vessel types. Controlling in-use emissions from other vessel types may be addressed in future rulemakings. This proposed regulation provides several compliance options, including an Alternative Control of Emissions plan. By focusing on the oldest, highest use engines first, the proposed regulation compliance dates provide early removal of the highest polluting engines, and engines that are beyond their useful service life.

Only in-use ferries, excursion vessels, tugboats, and towboats would be subject to these in-use engine operational requirements under the proposed regulation. Diesel engines on these vessel types are about 25 percent of the commercial harbor craft inventory, but produce about 50 percent of the emissions. As shown in Chapter IV, these vessels work close to shore a much more significant amount of time than other vessel types that contribute a significant portion of the emissions. Emissions released far offshore present a lesser health risk than near-shore emissions. Consequently, reducing emission from near shore sources are being addressed first. The following sections will explain U.S. EPA's engine emission standard structure, the compliance schedules, compliance extensions, and the basic proposed regulatory approach to control emissions from these sources.

(i) Emission Limits

The proposed regulation requires that in-use unregulated (Tier 0 or pre-Tier 1) and Tier 1 propulsion and auxiliary marine diesel engines on ferries, excursion vessels, tugboats, and towboats meet emission limits equal to or cleaner than the U.S. EPA marine engine standards in effect on the compliance date specified in the proposed regulation. The proposed regulation also allows the harbor craft owner/operator to demonstrate that the current engine meets the U.S. EPA marine engine Tier 2 standard or cleaner. Once an engine is replaced with a Tier 2 or 3 engine or can be shown to meet the applicable standards, all compliance requirements for that engine will have been met. For many vessels, their existing engines will not be able to meet the current marine engine standards. Therefore, repowering the vessel with a new engine will be the most likely option used to meet the requirements of the regulation.

The emission limit requirements for the regulation are based on the U.S EPA Marine Engine Standards. The U.S. EPA Marine Engine Standards have phased effective dates and emission levels dependent on the engine size, e.g. the cylinder displacement, and maximum power rating. See Chapter II for a more detailed discussion for the

U.S. EPA marine engine size categories and standards. Table V-1 illustrates the U.S. EPA engine tiers and implementation dates.

Table V-1: U.S. EPA Marine Engine Standards and Implementation Years

U.S. EPA Tiers	Effective Dates
Tier 0 (unregulated)	Pre-2000[A]
Tier 1	1999 - 2004
Tier 2	2004 - 2007
Tier 3[B]	2009 - 2014
Tier 4[B]	2014 - 2017

[A] Pre-1999 for engines less than 50 hp
[B] Proposed dates (EPA, 2007)

With the exception of engines less than 50 hp, all engines manufactured prior to 2000, are considered Tier 0 or unregulated engines. The U.S. EPA included marine engines less than 50 hp under the off-road Tier 1 new engine emission standards, which became effective in 1999. For marine engines equal to 50 hp and larger, U.S. EPA adopted Tier 1 limits consistent with the International Maritime Organization (IMO) Annex VI. These Tier 1 marine engine standards apply only to NOx+HC and became effective for the 2004 model year. However, engine manufacturers began complying with these limits starting with the 2000 model year because the IMO standards would become retroactive to 2000 once ratified by a majority of the participating nations.

The U.S. EPA Tier 2 marine engine emission standards became effective for engines manufactured in 2004 to 2007, depending on engine size. The standards for the medium and smaller size engines (generally less than 750 hp) became effective in 2004 and 2005, and the standards for the larger engines became effective in 2007. These Tier 2 standards are more stringent than the Tier 1 standards and include limits for PM, NOx+HC, and CO.

In January 2007, U.S. EPA published a Notice of Proposed Rulemaking (NPRM) for Locomotive and Marine Engines. The NPRM proposes new Tier 3 and Tier 4 emission standards to become effective for engine model years 2009-2014 for Tier 3 and 2014 to 2017 for Tier 4 engines. Effective dates depend on engine per cylinder displacement. The Tier 4 standards are proposed only for engines with maximum power ratings over 800 hp. Staff is proposing to require only standards as stringent as Tier 3 for in-use engine replacement. Installing after-treatment on replacement engines to meet Tier 4 standards could pose installation as well as safety concerns.

The proposal's requirements involving USEPA's proposed Tier 3 and Tier 4 standards would come into effect only if USEPA finalizes and promulgates those standards as they were specified in the NPRM. If USEPA promulgates different Tier 3 and Tier 4 standards, staff will need to return to the Board with a separate rulemaking to incorporate those Tier 3 and Tier 4 standards.

(ii) Compliance Schedule

Staff is proposing two compliance schedules for the in-use engine requirements for ferries, excursion vessels, tugboats, and towboats. These requirements are applicable to Tier 0 and Tier 1 engines on these vessel types that operate 300 hours or more annually. The years in which a vessel owner/operator's engines must meet the proposed emissions limits are given in the compliance schedules presented in Table V-2 and V-3 below. Compliance dates are based on the model year of the engine and the hours of operation.

The engine model year would be determined by one of three methods. In most cases, the engine's actual model year of manufacture would be used to determine the required compliance date. However, if certain steps have been taken to reduce the emissions of the engine, an "effective model year" may be calculated based on the following:

- o implementing an emission control strategy that obtains at least a 25 percent reduction in either PM or NOx, would extend the engine model year by five years. This is referred to as the "Engine's Model Year + 5" method. The date at which the engine must meet the U.S. EPA marine engine standards would be based on the engine model year plus five years;
- o demonstrating that the engine has been rebuilt to Tier 1 standards or cleaner prior to January 1, 2008 would allow the date of rebuild to be used as the engine's model year for determining when the engine must meet the U.S. EPA marine engine standards. This is referred to as the "Engine's Tier 1 Rebuild Model Year."

Table V-2 presents the proposed Statewide schedule for compliance. This compliance schedule applies to all ferries, excursion vessels, tugboats, and towboats except those whose homeports is in the SCAQMD. The proposed compliance schedule for vessels whose home port is in the SCAQMD is presented in Table V-3.

Early compliance dates, as shown in Table V-3, for the SCAQMD are necessary in order to provide early emission reductions from harbor craft to assist the SCAQMD in meeting its PM2.5 and ozone attainment goals. The SCAQMD is required to attain the PM2.5 standards by 2015, but must demonstrate that goals are met in 2014. NOx emission reductions are needed because NOx leads to formation in the atmosphere of both ozone and PM2.5; diesel PM emission reductions are needed because diesel PM contributes to ambient concentrations of PM2.5. The South Coast air basin is expected to have until 2023 to attain the federal ozone standard by invoking the "bump-up" provision in the Clean Air Act. Requiring SCAQMD vessels to comply with an accelerated compliance schedule will result in emission reductions earlier than for the rest of the State. Because harbor craft can move from one area of the State to another to work, the proposal also addresses the situation when a vessel from outside of the SCAQMD is used as a temporary replacement vessel within the SCAQMD. In this case, the proposal exempts that vessel from the SCAQMD engine compliance schedule but still requires the vessel to meet the Statewide compliance schedule.

Table V-2: Compliance Dates for Vessels with Homeports Outside SCAQMD

Engine Model Year	Total Annual Hours of Operation	Compliance Year
1975 and earlier	= 1500	12/31/2009
1975 and earlier	= 300 and <1500	12/31/2010
1976 – 1985	= 1500	12/31/2011
1976 – 1985	= 300 and <1500	12/31/2012
1986 – 1995	= 1500	12/31/2013
1986 – 1995	= 300 and <1500	12/31/2014
1996 – 2000	= 1500	12/31/2015
1996 – 2000	= 300 and <1500	12/31/2016
2001 – 2002	= 300	12/31/2017
2003	= 300	12/31/2018
2004	= 300	12/31/2019
2005	= 300	12/31/2020
2006	= 300	12/31/2021
2007	= 300	12/31/2022

[Note: For example, if a 1982-model year diesel engine on a tugboat operating in Regulated California Waters is used for 750 hours in 2011, the owner or operator must bring the engine into compliance with the emission standards by December 31, 2012.]

Table V-3: Compliance Dates for Vessels with Homeports in SCAQMD

Engine Model Year	Total Annual Hours of Operation	Compliance Year
1979 and earlier	= 300	12/31/2009
1980 – 1985	= 300	12/31/2010
1986 – 1990	= 300	12/31/2011
1991 – 1995	= 300	12/31/2012
1996 – 2000	= 300	12/31/2013
2001	= 300	12/31/2014
2002	= 300	12/31/2015
2003	= 300	12/31/2016
2004	= 300	12/31/2017
2005	= 300	12/31/2018
2006	= 300	12/31/2019
2007	= 300	12/31/2020

[Note: For example, if a 1982-model year diesel engine on a tugboat operating in Regulated California Waters is used for 300 or more hours in 2009, the owner or operator must bring the engine into compliance with the emission standards by December 31, 2010.].

(iii) Compliance Options

Staff is proposing that in-use Tier 0 (pre-Tier 1) and Tier 1 marine engines on ferries, excursion vessels, tugboats, and towboats meet emission limits equal to or cleaner than the U.S. EPA marine engine Tier 2 or Tier 3 emission standards applicable on the compliance date. The proposed regulation does not require compliance with Tier 4 (after-treatment based) standards for in-use engines due to issues with the additional weight and space requirements associated with applying after-treatment technologies to existing vessels.

While we expect the primary method for compliance with the proposal is the replacement of in-use engines with certified Tier 2 or Tier 3 engines, the proposed regulation includes other options for compliance. These options include:

- demonstrating that the current engine meets the applicable U.S. EPA marine engine standards;
- demonstrating that the current engine has not been operating 300 hours or more per calendar year and will continue to operate at this low usage rate in the future.

If the engine is replaced with a Tier 2 or 3 engine, or can be shown to meet the applicable standards, all compliance requirements for that engine will have been met.

The ARB staff anticipates that, in most cases, engine replacement will be the option chosen by vessel owners and operators to meet the proposed emission standards for vessels. Ferries, excursion vessels, tugboats, and towboats are good candidates for repowering because these vessel types have an extensive history of being repowered. Almost 50 ferries, excursion vessels, tugboats, and towboats statewide have been repowered over the last six years through the Carl Moyer Program.

(iv) General Compliance Date Extensions

The proposed regulation also includes a provision by which the ARB Executive Officer may grant a vessel owner or operator a compliance extension beyond the deadline of the regulation. The reasons for granting an extension are:

- a vessel is within one year of retirement,
- change of vessel hours of operation during the year prior to the anticipated engine compliance date such that the effective compliance date would be accelerated by one year,,
- no suitable engine replacement for a particular vessel,
- delayed engine repower delivery due to the engine manufacturer, installation difficulties, or
- multiple vessels with engines requiring compliance within the same calendar year.

If an extension is required because there is no suitable engine replacement for a particular engine, the owner or operator is required to apply for this extension at least six months prior to the engine regulatory compliance date. The approval process for this extension includes a public review and comment period.

(v) Alternative Control of Emissions (ACE)

The need for flexibility is important when considering options to reduce emissions from harbor craft. The proposed regulation includes an ACE option for owner/operators of harbor craft that would allow them to demonstrate that equivalent emission reductions would be achieved, or exceeded, using alternative strategies. Alternative strategies can include engine modifications, exhaust after-treatment control, engine repower, using alternative fuels or fuel additives, or fleet averaging. ACE applications must be approved by the Executive Officer and be made available for public review and comment prior to Executive Officer action. Until such approval is granted the owner or operator would be required to meet the performance requirements in the proposed regulation.

(vi) Diesel Emission Control Strategy Special Circumstances

If a diesel emission control strategy is part of an owner/operator's compliance option and the diesel emission control strategy fails during or after the warranty period, then the owner or operator has 90 days to replace the diesel emission control strategy or comply with another compliance option.

(vii) Multipurpose Harbor Craft

There are many harbor craft in the State that work as ferries, excursion vessels, and tugboats, and towboats and are also used as a work, crew, pilot, fishing, supply, or other type of vessel. If the vessel is used at any time during the year as a ferry, excursion vessel, tugboat, or towboat, the vessel's engines will be required to meet the compliance schedule of the proposed regulation. The vessels total annual hours of operation will be used to determine the compliance schedule dates.

REFERENCES:

(EPA, 2007) U.S. Environmental Protection Agency. *Draft Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters Per Cylinder.* EPA 420-D-07-001, March, 2007.

VI. FEASIBILITY OF THE PROPOSED REGULATION

In this chapter, ARB staff will discuss the technical feasibility of regulatory compliance options available to owner/operators of ferries, excursion vessels, tugboats, and towboats subject to the in-use engine compliance requirements of the proposed regulation. The primary option by which staff expect vessel owner/operators to comply is engine replacement (repowering). Other options include using a diesel emission control strategy that reduces emissions by at least 25 percent. However, this option only delays the compliance date at which the engine must conform to the emission limits. This chapter includes short descriptions of different emission control strategies and several demonstration projects using different control strategies. A discussion of the State's capacity for a large number of engine repowers is included along with information about incentive funding available to harbor craft owner/operators should they choose to comply with the regulation early. The chapter ends with a discussion of the feasibility of using BACT with new ferry propulsion engines.

A. Repowering Vessels

The ARB staff anticipates that the majority of ferry, excursion vessel, tugboat, and towboat owner/operators will choose to comply with the in-use engine requirements of the proposed regulation by replacing (repowering) their Tier 0 and Tier 1 engines with a new Tier 2 or Tier 3 engine. This will result in substantial emissions improvements. Heavy-duty marine diesel engines currently being manufactured are significantly cleaner than those built just a short time ago and can provide significant PM and NOx benefits compared to an older engine. (Diesel, 2003) Replacing a Tier 0 marine engine with a Tier 2 engine provides approximately a 60 percent reduction in both PM and NOx emissions. Replacing with a Tier 3 engine increases this reduction to 80 percent for PM and 70 percent for NOx.

The process of replacing an engine in a harbor craft takes a considerable amount of planning prior to actually beginning the work of replacing the engine. Harbor craft owner/operators must decide on replacement engines that will meet their operational needs; in many cases, the engine replacement plans must be reviewed and approved by the U.S. Coast Guard; the engine must be purchased and shipped to the facility that will be doing the replacement procedure; and dry dock time must be scheduled with a local boat repair/building facility to have the replacement done.

Propulsion engine replacement, on average, requires about two to three weeks per engine. Many of these vessels have two propulsion engines so this doubles the time. Because propulsion engines are generally an integral part of the vessel, in many cases, a hole would need to be cut in the deck or side of the vessel to remove and replace the engine. Since new engines are typically smaller and lighter than the old engines, fitting the engine into the space occupied by the old engine would generally not be an issue. However, it may be necessary to replace the gears and the propeller shaft to accommodate the new engine.

Auxiliary engine replacement on harbor craft can be less complicated. Because auxiliary engines are generally more ancillary to the vessel, replacement is less complex and sometimes can be done without going into dry dock. While engine replacement is not a simple task, it has been shown to be feasible on many occasions. Since the inception of the Carl Moyer Program in 1998, about 400 older dirtier propulsion engines on harbor craft have been replaced with cleaner, newer engines.

On the other hand, applying retrofits to marine engines presents multiple challenges that have yet to be fully worked out. Marine applications present a challenge due to the uniqueness of each application, harsh operating conditions, and safety concerns. Most harbor craft have unique vessel designs and retrofit devices are not available "off-the-shelf" for marine installations. Rather, retrofit technologies have been custom built to fit a particular vessel in the few instances where retrofits have been applied.

The relatively small size of the marine retrofit market also provides less incentive for investments by emission control system manufacturers. Safety concerns include the impact of the additional weight of the emission control equipment, line of sight concerns, and the need for high engine reliability. While staff believes that the expanded development of retrofit strategies for marine applications is likely, the market is not sufficiently mature at this time to require retrofits for all vessels. Nevertheless, as discussed previously in Chapter V, the proposed regulation is designed to provide flexibility by allowing the use of retrofits and other engine control technologies to meet the proposed emission requirements provided the vessel operator can demonstrate the necessary emission reductions.

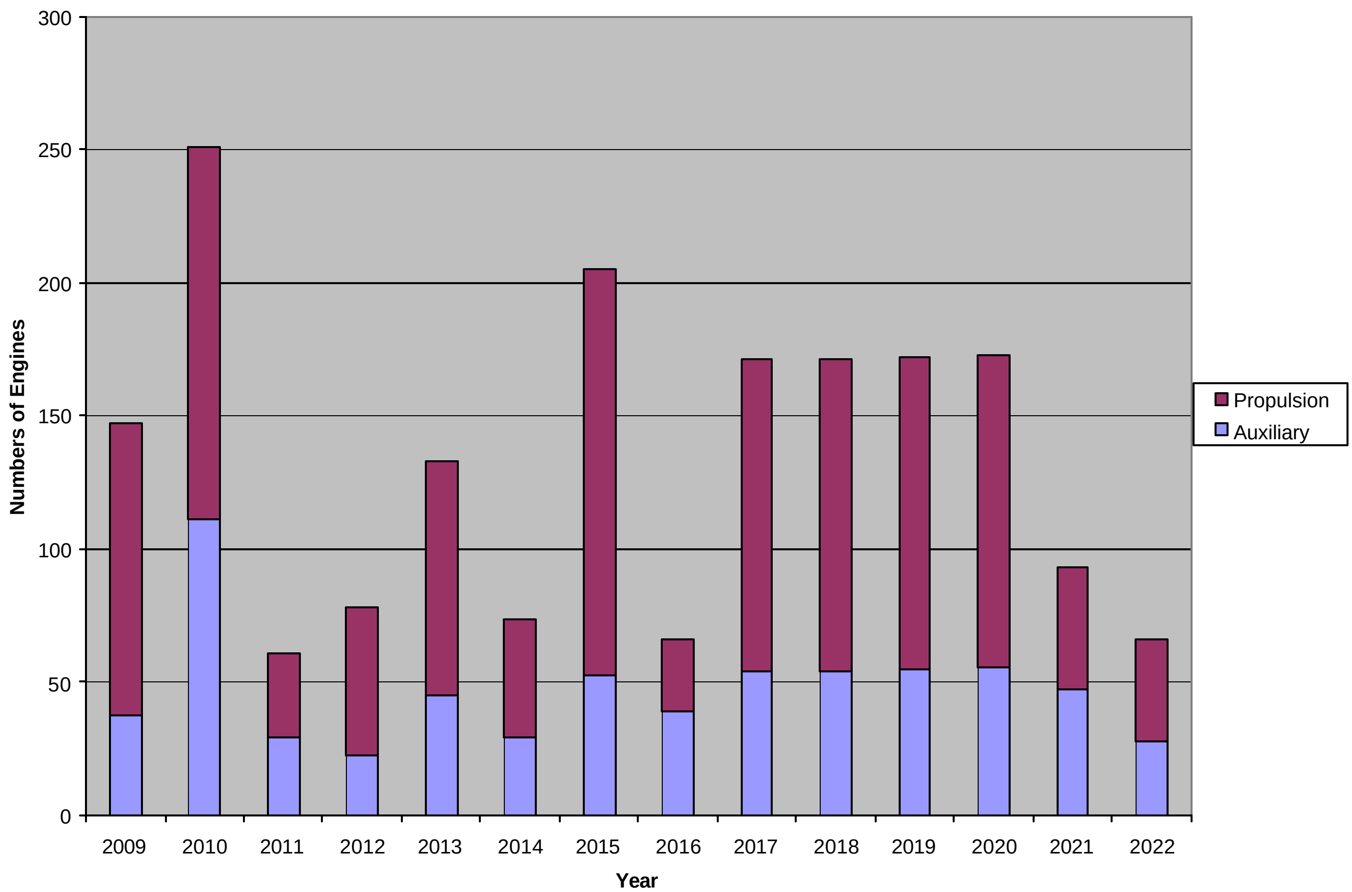
B. Statewide Capacity for Engine Replacements

A key aspect to the successful implementation of the proposed regulation is the ability of the State's boat yards, boat building, and boat repair facilities to accommodate the anticipated number of engine replacements due to the in-use engine compliance requirements of the proposed regulation. To evaluate the statewide capacity for engine replacements, ARB staff: 1) estimated the numbers of in-use engines on ferries, excursion vessels, tugboats, and towboats required to come into compliance with the emissions limits (primarily through replacement) per year using the ARB Survey information and engine population data from the emissions inventory; and 2) conducted a phone survey of boat yards, boat building, and boat repair facilities in California to determine the annual statewide capacity for harbor craft engine replacements. Based on this outreach effort, staff has determined that the number of engine replacements that would occur due to the proposed regulation's compliance schedule would be achievable considering the State's capacity. Below, more details are provided on ARB staff's approach and findings pertaining to the statewide capacity for engine replacements.

The numbers of both auxiliary and propulsion engine replacements anticipated per year are shown in Figure VI-1. An average of 128 replacements of both auxiliary and propulsion engines per year are anticipated over the 14-year compliance period. Of the

128 engine replacements, over 60 percent, or about 80 engines, are propulsion engine replacements. Because auxiliary engine replacements are less involved and do not necessarily require a dry dock facility, staff assumed dry docking for the propulsion engine replacements would be the limiting factor for the State's capacity. While the 14-year average for propulsion engine replacement is 80 engines, the maximum number of propulsion engine repowers required in one year (2015) is estimated to be about 150. The next highest estimate is 140 engines in 2010 followed by a four-year period from 2017–2020 with about 120 engines each year.

Figure VI-1: Estimated Numbers of Harbor Craft Engines Replaced Annually Due to Implementation of the Proposed Regulation



To determine if there is sufficient capacity to handle the potential business generated by the implementation of the proposed regulation, ARB staff conducted a telephone survey of more than 50 boat yards, boat builders, and boat repairers throughout California. (ARB, 2007) These facilities provide marine engine rebuilds, overhauls, scheduled and emergency maintenance, as well as engine replacements. All the facilities were active businesses. These facilities generally schedule jobs a minimum of three or four weeks in advance. At the time ARB staff contacted them in May 2007, most were booked through the summer months. In the phone survey, staff collected information on where the business was located, whether or not the business performed engine replacements, any size limitations on the vessels serviced, and the estimated numbers of engines replaced annually.

Based on this survey and as shown in Table VI-1, staff estimates that the total statewide capacity for engine repowers ranges from about 220 to 270 per year.

Table VI-1: Statewide Engine Replacement Capacity

Region of the State	Numbers of Engines (per year)
Northern California	76 – 101
Los Angeles	93 – 110
San Diego	48 – 60
Total Capacity Statewide	217 – 271

Additional information on statewide capacity for harbor craft engine replacements can be inferred from the implementation of the Carl Moyer Program. Over the past 6 years, an annual average of about 65 to 70 marine propulsion engines have been replaced through incentive funding provided by the State's Carl Moyer Program. Based on the survey data above, these represent about 25 to 30 percent of the estimated State capacity.

Some of the engine replacement could also occur in place of an operator's normal vessel maintenance activities that would occur in dry dock such as engine rebuild, overhaul, or some other maintenance during the year, or in the next few years. This would have the effect of increasing the available capacity. Staff also anticipate that some vessel owner/operators will replace their engines early in order to be eligible for incentive funding. These voluntary early repowers would shift the distribution of repowers and more evenly distribute the workload on the industry.

Based on these findings, ARB staff believes that California's boat yards, boat builders, and boat repairers currently have the capacity to absorb the numbers of engine replacements that would result from the implementation of the proposed regulation. At the same time, staff believe that the proposed compliance schedule is the upper bound for marine engine replacements, and implementing a compliance schedule that would increase the numbers of marine engine repowers in a given year would over-extend the capacity of California's boat yards, boat builders, and boat repairers to provide quality service in a timely manner.

The ARB staff will be doing additional outreach to California's boat yards, boat builders, and boat repairers to keep them abreast of the status of the proposed regulation. Outreach will allow California's boat yards, boat builders, and boat repairers to prepare for the additional business resulting from the implementation of the proposed regulation.

C. Grant Funding Availability

The use of incentive and grant programs can play an important role in reducing emissions from harbor craft. Under the proposed regulation, vessel operators can continue to leverage grant monies provided they meet the criteria for the funding program. In most cases, an operator will need to comply with the regulation earlier than required to be eligible for funding. The following paragraphs discuss three incentive/grant funding sources that may be available to vessel owner/operators. More information on grant funding and the economic impacts of the proposed regulation are provided in Chapter VII.

1. Federal Grants

The Federal Transit Authority (FTA) has provided a number of California-based publicly-funded ferry operations with funding grants in the recent past. The FTA has provided approximately 77 million dollars in grant funding to five California-based publicly-funded ferry operations.

The FTA makes grant funding available to public agencies that have legal authority to receive and dispense federal funds. The recipients of the grant funding are responsible for managing their projects in accordance with Federal requirements. (FTA, 2007)

2. The Carl Moyer Memorial Air Quality Standards Attainment Program

Repowering harbor craft has been on-going throughout the State under the auspices of California's Carl Moyer Memorial Air Quality Standards Attainment Program (Moyer) for eight years. As of the 2003-2004 fiscal year, about 400 propulsion and 50 auxiliary engines had been replaced in approximately 300 harbor craft. The types of vessels that have participated in the Moyer program are representative of all types of harbor craft; ferries and excursion vessels, tugboats, towboats, commercial fishing vessels, charter fishing vessels, and others.

The Moyer Program provides funds on an incentive basis for the incremental cost of cleaner than required engines and equipment which result in significant near-term reductions in NOx and PM emissions. Marine vessel repowers in the Moyer Program are required to achieve a minimum of a 15 percent reduction in NOx emissions to be eligible for funding. The average engine replacement cost was approximately $100,000 and the average Moyer contribution per engine was approximately $54,000. Emission reductions from marine vessels achieved through Moyer in the first seven years totaled 1,250 tons per year of NOx and 75 tons per year of PM at a NOx-weighted average cost effectiveness of $1,800 per ton. (ARB, 2006)

3. California Goods Movement Bonds

In November 2006, California voters approved Proposition 1B which, when implemented, would provide $1 billion in incentive funding to reduce emissions from goods movement activities. Enabling legislation is required before these funds can be made available to ARB, and may provide additional direction regarding fund project categories and funding recipients. Some of these funds may become available to harbor craft involved in goods movement activities.

D. Alternative Emission Control Strategies

The proposed regulation allows for alternatives to engine replacement to meet the requirements to reduce emissions of diesel PM and NOx from harbor craft. For example, an operator can chose to demonstrate that the vessel engines meet the applicable U.S. EPA Marine Engine Standard through the application of retrofit control devices or engine modifications. In addition, an operator can chose to install an emissions control strategy that reduces PM or NOx by a minimum of 25 percent. Implementing an alternative emission control strategy that reduces emissions by 25 percent, however, does not exempt a harbor craft owner/operator from ultimately meeting the U.S. Marine Engine Standards, rather, this option provides for a 5-year compliance extension.

The alternatives available to a harbor craft owner/operators range from aftertreatment controls to engine modifications. While many control technologies have been proven to reduce emissions of PM and NOx from land-based diesel-fueled engines, there is limited experience in applying these to harbor craft. In addition, to date, there are no emission control strategies verified by the ARB for marine applications.

Several factors impact the selection of an alternative emission control strategy including the engine's duty cycle, the exhaust system configuration, the placement of the engine in the hull, the weight of the proposed emission control strategy, and engine age. In addition, any design modification must be approved by the U.S. Coast Guard prior to changes being made.

Table VI-2 provides general descriptions of diesel PM and NOx emission reduction control strategies that have been used in diesel applications. A brief description of demonstration projects where the technology has been applied in the marine environment is also included. Additional discussion on selected demonstration projects if provided in Section E of this chapter. For more information on the various control technologies and demonstration projects, the reader is directed to Appendix E.

Table VI-2: Alternative Marine Application Emission Control Strategies

Control Technology	Brief Description	Potential Emission Reductions		Demonstration Projects
		Diesel PM	NOx	
Diesel Particulate Filters (DPF)	Removes PM through physical filtration. Most common type is “wall-flow” filter - exhaust gas forced to flow through porous channel walls due to blocked channel ends	85%	0%	One project to date, a DPF was installed on an auxiliary engine of a ferry. Emission testing results have not been provided.
Diesel Oxidation Catalysts (DOC)	Aftertreatment with catalytic surfaces that enhance the combustion of carbonaceous pollutants	25%	0%	There is anecdotal evidence that DOCs have been installed on excursion vessels in Europe with some success. No specific data available.
Flow-through Filters (FTF)	Densely packed material that either traps PM or causes turbulent exhaust flow to enhance combustion of unburned hydrocarbons	50–75%	0%	One installation on a work boat with 400 hp Detroit Diesel propulsion engines. Emission testing results available.
Selective Catalytic Reduction (SCR)	Injects ammonia or urea into the exhaust, in the presence of a catalyst, to reduce NOx to nitrogen and water	0%	50–85%	SCR has been used in European ferries for a number of years. There has been an installation on a ferry in New York City. The ferry has two 1,500 hp Caterpillar engines. The SCR has been installed and working since 2005. Here in California, SCR was installed on a catamaran ferry with two MTU/DDC 3,100 hp engines. Recent information indicates this application has issues that need to be addressed.
Water/Fuel Mixture	Water absorbs heat in the combustion chamber. This reduces the peak combustion temperature and, in turn, reduces NOx formation	0%	One-to-one water to NOx up to 20% water	One installation on a ferry with 1,000 hp Detroit Diesel propulsion engines. Emission testing results available.
Humidify Intake Air/ Water Injection at Air Intake	Water absorbs heat in the combustion chamber, reducing the peak combustion temperature which reduces NOx formation	0%	15–25%	Humid Air system tested on high speed hydrofoil ferry – 1050 hp engines. Water injection tested on Tier 0, 360 hp, ferry engine.

Table VI-2: (cont.). Alternative Marine Application Emission Control Strategies

Control Technology	Brief Description	Potential Emission Reductions		Demonstration Projects
		Diesel PM	NOx	
Engine Rebuild Kits	An engine will be rebuilt from the block up with new pistons, rings, etc. with modifications to increase combustion efficiency and/or reduce pollutants	40%	35%	Engine rebuild kits have been installed on tugboat EMD engines. No specific data available.
Clean Cam	Engine rebuild technology, includes a proprietary cam shaft, cylinder liners, and turbo charger modification. The new cam provides an opportunity for residual exhaust gas to absorb heat and reduce combustion temperatures thereby reducing NOx formation	30% - Benefit dependent on the horsepower of the engine	70% - Benefit dependent on the horsepower of the engine	One installation on a work boat with 400 hp Detroit Diesel propulsion engines. The Clean Cam technology is specific to Detroit Diesel Series 71 engines. Emission testing results available.
ECOTIP Fuel Injectors	Provides more consistent fuel injection pressure and minimizes the amount of fuel entering the combustion chamber after the fuel injection cycle	40%	0%	ECOTIP fuel injectors have been installed on tugboat s. No specific data available.
Alternative Fuels	Impacts on emissions depend on the fuel type	Fuel Dependent	Fuel Dependent	One demonstration of the potential of biodiesel in the marine sector. Biodiesel, B20 and B100, was used on a ferry prior to engine replacement. A report of the results available.
Fuel Cells	Converts chemical energy to electricity by combining oxygen from the air with fuel	100%	100%	No fuel cells are currently in-use in marine applications. The WTA plans to include fuel cell technology as the auxiliary engine in a future vessel.
Exhaust Gas Recirculation (EGR)	Reduces the combustion temperatures in the combustion chamber by diluting the mixture in the chamber. Reduced combustion temperatures reduces NOx formation	PM disbenefit 50-300%	15-50%	To date, there have been no demonstrations of this technology with a marine application.

E. In-Use Experience with Diesel Emission Control Strategies

1. Demonstration Projects

There have been a number of demonstration projects nationwide funded primarily through public agencies to implement installation of aftermarket emission controls for harbor craft. Brief discussions of some of these demonstration projects are presented below.

a. Diesel Particulate Filter on U.S. Navy Workboat

In 2006, one of two DDC 12V-71 400 horsepower engines on a U.S. Navy workboat operating in the Suisun Bay was rebuilt with Clean Cam Technology (CCT) system, including combustion chamber and injector modifications and the addition of a turbocharger. Based on preliminary emissions tests results, the rebuilt engine reduced PM emissions by over 30 percent and NOx emissions by approximately 70 percent. A Rypos active flow-through DPF was tested on the engine before it was rebuilt with CCT. This filter achieved a PM reduction of approximately 70 percent and a small NOx reduction. Used together, the CCT and Rypos active DPF achieved over 80 percent PM reduction and over 70 percent NOx reduction. Durability testing of the system was completed in late 2006.

This is project is a prime example of the uniqueness associated with the installation of marine-related aftertreatment controls. The DPF was engineered specifically for the space available below deck, the average engine load, and the size of the engines powering the vessel. In addition, modifications were made to the vessel's exhaust system to ensure that there would be no intrusion by salt water into the system.

This demonstration shows that DPFs are a technology that has the potential for wider marine applications if steps are taken to ensure that the control device is sized appropriately and any unique feature of the vessel design or operation is addressed in the system's design.

b. Selective Catalytic Reduction

(i) Vallejo Baylink Ferry

In 2004, the Vallejo Baylink Ferry launched M/V Solano, a low emissions ferry utilizing a urea-based SCR system made by Steuler GmBH. This system was based on an SCR designed for stationary sources. This ferry is part of the passenger ferry system which services Vallejo and the North San Francisco Bay. The SCR system was used with the two MTU/DDC 16V-4000 propulsion engines with rated power of 3100 hp each. The SCR system was designed to reduce NOx by 57 percent. (Baylink, 2006; MARAD, 2003)

In July of 2007, engine alarms indicating high cylinder temperature were set off in the MV Solano's propulsion engines. BayLink staff inspected the engine and the SCR unit. They found that a number of the starboard engine cylinders showed excessive wear as well as ring damage. Upon opening up the starboard SCR unit, they found extensive damage to the catalyst blocks. The catalyst block damage included what appeared to be salt water corrosion and excessive heat and mechanical impacts. The BayLink staff have published a report and continue to look into the potential reasons for the damage to the engine and the SCR unit. (BayLink, 2007)

(ii) Staten Island Ferry

The two Caterpillar 3516 1,550 horsepower propulsion engines of the M/V Alice Austen were retrofitted with SCR and diesel oxidation catalyst in 2004. The system was designed to reduce NOx by 50 percent as well as PM by 25 percent. (Bradley, 2006)

The M/V Alice Austen has been operating with SCR since 2005. The vessel is in service during the night runs of the Staten Island Ferry system (9 p.m. to 5 a.m.). The route the vessel is assigned takes about an hour and includes two 20-minute runs and idling during passenger loading and unloading. There have been no problems with the SCR system.

(iii) San Francisco Bay Area Water Transit Authority (WTA) Ferry

The WTA is planning to build two new 149 passenger ferries to be put into service in late 2008 which will include exhaust aftertreatment to reduce NOx emissions by at least 85 percent beyond Tier 2 standards. The ferries are being designed to incorporate a compact SCR system coupled with an oxidation catalyst with the 1410 hp Detroit Diesel propulsion engines. The inclusion of the aftertreatment system will require about six feet to be added to the vessel's overall length. The system was derived from one that has been used on other mobile equipment. The ferries' design includes a dry exhaust with a high exhaust stack. (WTA, 2006a)

(iv) Foss Tugboat with Hybrid System

The Foss Tug Company of Seattle, Washington recently "laid keel" on a Dolphin class hybrid tugboat. The tugboat will be a stern drive vessel used primarily for harbor assist services. The tugboat's electric drive units will be powered by two 670 horsepower battery packs coupled with two 335 horsepower diesel-fueled generators. Although the main engines will have lower horsepower than those found in the existing Dolphin class tugboats, the total horsepower of the hybrid tugboat will be equal to that of the existing Dolphin class tugboats – about 5,000 hp.

Foss anticipates a number of benefits from the use of hybrid technology. These benefits include over a 40 percent reduction in emissions of PM and NOx, lower fuel consumption, and a reduction in the noise associated with the operation of the vessel. It is anticipated that the vessel will begin operations in 2008.

(v) Humid Air Injection

SCX Ferries, Inc and MARAD tested the emission reduction potential of an air humidification system on a hydrofoil ferry in San Diego, California. The ferry is powered by four high-speed Detroit Diesel 12V92 diesel-fueled engines, each rated at 1050 hp driving two water jets. The water injection (fumigation) system reduces NOx by reducing peak combustion temperatures. The system was able to reduce NOx by about 16 percent. (MARAD, 2003)

c. <u>Combined Technologies</u>

In 2006, Cleaire worked with Blue and Gold Ferries in San Francisco to install an aftertreatment control system on a ferry. The system installed consisted of a DPF and a lean NOx catalyst element. The lean NOx catalyst element was a diesel fuel injector located down-stream of the DPF. The diesel fuel served as a catalyst to reduce NOx.

The aftertreatment control system was sized and installed on the ferry based on a successful demonstration in on-road bus Detroit Diesel 4 stroke engines. The engines on the ferry were identical to those on the bus. During the course of emission testing the system on simulated ferry runs, the diesel fuel injector in the lean NOx catalyst element was thermally destroyed. After several attempts to resolve that issue, the demonstration and emission testing was discontinued. It is assumed that the failure was due to the difference in a ferries engine load and cycle when compared to that of an on-road bus.

2. Future Emissions Testing Opportunities

The ARB staff has plans to test and quantify the emission reductions achieved with several of the demonstration projects over the next one to two years. These projects include the Foss hybrid tugboat and the WTA low emission ferry. In addition, the Red and White Ferry in San Francisco has requested assistance in determining the emission reductions they are achieving using a biodiesel blend diesel fuel in one of their new ferries. ARB is also co-funding the emission testing of a compact SCR unit in combination with a crankcase filter installed on an EMD 710 3,100 horsepower engine operating with a marine engine cycle. The EMD engine is commonly used in tugboats. The emission testing will be conducted at the Southwest Research Institute.

F. Feasibility of Achieving Additional Emission Reductions From New-Build Ferry Propulsion Engines

The proposed regulation requires that all new-build ferries comply with an additional requirement for the ferry propulsion engines. In addition to having a propulsion engine that meets the current U.S. EPA marine engine emission standards, they must also install an after-treatment system that represents BACT at the time of acquisition to further reduce emissions of PM and NOx. The WTA requires that all new ferry propulsion engines achieve 85 percent lower emissions than the current engine standard. The two ferries currently being built for WTA, discussed above, are guaranteed to meet this requirement using SCR combined with an oxidation catalyst. However, the failure of the SCR system on the Baylink Ferry illustrates the need to successfully demonstrate this technology on a California high speed ferry.

While the Staten Island Ferry with SCR appears to be operating successfully, this is a larger slow speed vessel. There may be different design challenges for smaller catamaran type higher speed vessels such as the Baylink and WTA ferries. Staff chose not to prescribe specific emission reductions or technologies due to the lack of successful demonstrations. A BACT requirement is included in the proposed regulation to stimulate the development of emission control strategies for these vessels and allow additional reductions to be realized as technology develops.

REFERENCES:

(ARB, 2006) Joseph Calavita, California Air Resources Board. Personal communication. October 5-6, 2006.

(ARB, 2007) Kirk Rosenkranz, California Air Resources Board. Personnel communications with California boat builders and repair facilities. May 2007.

(Baylink, 2006) Martin Robbins, Baylink Ferry. Personal communication. October 24, 2006.

(Baylink, 2007) SCR Project-M/V Solano, June 30, 2007.

(DieselNet, 2003) DieselNet. http://dieselnet.com/tech/engine_adv.html

(FTA, 2007) Federal Transportation Administration. http://www.fta.dot.gov/grants_financing.html. August, 2007.

(MARAD, 2003) U.S. Department of Transportation Maritime Administration Office of Shipbuilding and Marine Technology. *Energy Technologies. Newsletter No. 04*; Winter 2003-2004.
http://www.marad.dot.gov/nmrec/energy_technologies/images/ETNo4Winter0304.htm
August 9, 2006.

(WTA, 2006a) San Francisco Bay Area Water Transit Authority. "The SF Bay Area Water Transit Authority is Building Boats." Press Release. May 9, 2006.
http://www.watertransit.org/pressreleases/pressRelease050906.pdf
October 18, 2006.

VII. ENVIRONMENTAL IMPACTS

This chapter describes the potential environmental impacts of this proposed regulation. This proposed regulation is intended to protect the health of California's citizens by reducing diesel engine emissions from harbor craft operating in California coastal and inland waters. An additional consideration is the impact that implementation of the proposed regulation may have on the environment. Based upon available information, the ARB staff has determined that no significant adverse environmental impacts should occur as the result of adopting the proposed regulation. This chapter describes the potential impacts that the proposed regulation may have on wastewater treatment, hazardous waste disposal, and air quality.

A. Legal Requirements

The California Environmental Quality Act (CEQA) and ARB policy require an analysis to determine the potential environmental impacts of proposed regulations. Because the ARB's program involving the adoption of regulations has been certified by the Secretary of Resources pursuant to Public Resources Code section 21080.5, the CEQA environmental analysis requirements may be included in the Initial Statement of Reasons (ISOR) for this rulemaking. In the ISOR, ARB must include a "functionally equivalent" document, rather than adhering to the format described in CEQA of an Initial Study, a Negative Declaration, and an Environmental Impact Report. In addition, staff will respond, in the Final Statement of Reasons for the regulation, to all significant environmental issues raised by the public during the public review period or at the Board public hearing.

Public Resources Code section 21159 requires that the environmental impact analysis conducted by ARB include the following:

- An analysis of reasonably foreseeable environmental impacts of the methods of compliance;
- An analysis of reasonably foreseeable feasible mitigation measures; and,
- An analysis of reasonably foreseeable alternative means of compliance with the regulation.

Compliance with the proposed regulation is expected to directly affect air quality and potentially affect other environmental media as well. Our analysis of the reasonable foreseeable environmental impacts of the methods of compliance is presented below.

Regarding mitigation measures, CEQA requires an agency to identify and adopt feasible mitigation measures that would minimize any significant adverse environmental impacts described in the environmental analysis.

The proposed regulation is needed to reduce the risk from exposures to diesel PM as required by Health and Safety Code (HSC) section 39666 and 39667, to help fulfill the goals of the October 2000 Diesel Risk Reduction Plan (ARB, 2000), and to help meet the goals of the Emission Reduction Plan for Ports and Goods Movement in California (ARB, 2006). The regulation is also necessary to fulfill ARB's obligations under HSC 43013 and 43018 to achieve the maximum feasible and cost effective emission reductions from all mobile source categories, including off-road diesel engines and equipment. The emission reductions from the proposed regulation in ambient levels of PM, NOx and reactive organic gases (ROG) will help make progress in meeting the State and Federal ambient air quality standards for ozone and PM in non-attainment areas of the State. Alternatives to the proposed regulation will be discussed in the Economic Impacts chapter of this report (Chapter VIII). ARB staff have concluded that there are no feasible alternative mitigation methods that would achieve similar diesel PM emission reductions at a lower cost.

B. Effects on Air Quality

The proposed regulation will provide diesel PM and NOx emission reductions throughout California, especially in areas having ports, areas which in most cases are non-attainment for the State and federal ambient air quality standards for ozone, PM10, and PM2.5. The projected controlled emissions from harbor craft engines are presented in Table VII-1.

Table VII-1: Projected Annual Harbor Craft Emissions with Proposed Regulation Implementation

Category	VI. 2004 EMISSIONS (tons/day)		2015 Emissions (tons/day)		2020 Emissions (tons/day)	
	PM	NOx	PM	NOx	PM	NOx
Commercial Fishing	0.8	17.4	0.4	7.8	0.2	5.6
Charter Fishing	0.6	12.7	0.3	8.2	0.2	6.6
Ferries/Excursion	0.9	21.0	0.5	14.3	0.3	9.3
Tug	0.6	15.3	0.2	6.9	0.2	5.4
Tow	0.1	3.0	0.1	1.6	<0.1	1.4
Crew and Supply	0.1	1.4	<0.1	0.8	<0.1	0.7
Pilot	<0.1	0.4	<0.1	0.2	<0.1	0.2
Work/Other	0.1	2.0	<0.1	1.2	<0.1	1.1
Total	3.3	73.2	1.6	41.2	1.0	30.9

Note: The numbers may not sum exactly due to rounding.

The reductions due specifically to the regulation are summarized in Table VII-2 and Table VII-3 below. As can be determined from the information provided in the tables, PM emissions will be 30 percent lower in 2015 and over 40 percent lower in 2020 than they would be without the regulation. The estimated NOx emissions are 23 percent lower and 25 percent lower in 2015 and 2020, respectively due to the implementation of the proposed regulation.

Table VII-2: Projected Statewide Diesel PM Benefits of the Proposed Regulation

Year	PM without Regulation (tons/day)	PM with Regulation (tons/day)	Emission Reductions from 2004 (tons/day)	% Emission Reductions from 2004
2004	3.3	3.3	0.0	0
2010	2.6	2.5	0.7	22
2015	2.3	1.6	1.6	50
2020	1.7	1.0	2.2	68
2025	1.2	0.9	2.4	74

Table VII-3: Projected Statewide NOx Benefits of the Proposed Regulation

Year	NOx without Regulation (tons/day)	NOx with Regulation (tons/day)	Emission Reductions from 2004 (tons/day)	% Emission Reductions from 2004
2004	73	73	0	0
2010	61	59	14	19
2015	54	41	32	44
2020	41	31	42	58
2025	32	28	45	62

When the combined benefits of the proposed regulation are considered in conjunction with existing programs, such as the ARB fuel regulations and U.S. EPA's marine engine standards, the overall reductions in diesel PM and NOx emissions from harbor craft are significant. As shown in the tables above, diesel PM emissions from harbor craft will be reduced by 50 percent in 2015 and 74 percent in 2025 relative to what the emissions were in 2004. NOx emissions will be reduced 44 percent in 2015 and 62 percent in 2025 relative to the 2004 baseline.

Figure VII-1 and Figure VII-2 show the projected diesel PM and NOx emissions for California's harbor craft fleet, both baseline emissions and with the impacts of the proposed regulation. We also anticipate reductions in reactive organic compounds and carbon monoxide; however, the emission reductions from these pollutants are not yet quantified in the emissions inventory.

Figure VII-1: Projected Diesel PM Emissions With and Without the Proposed Regulation

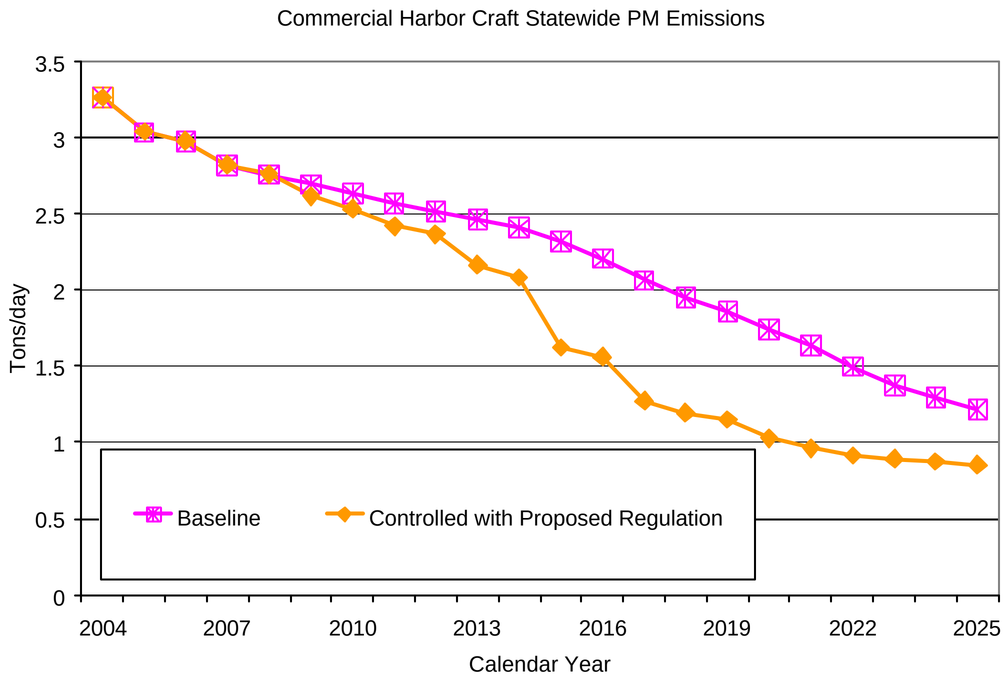
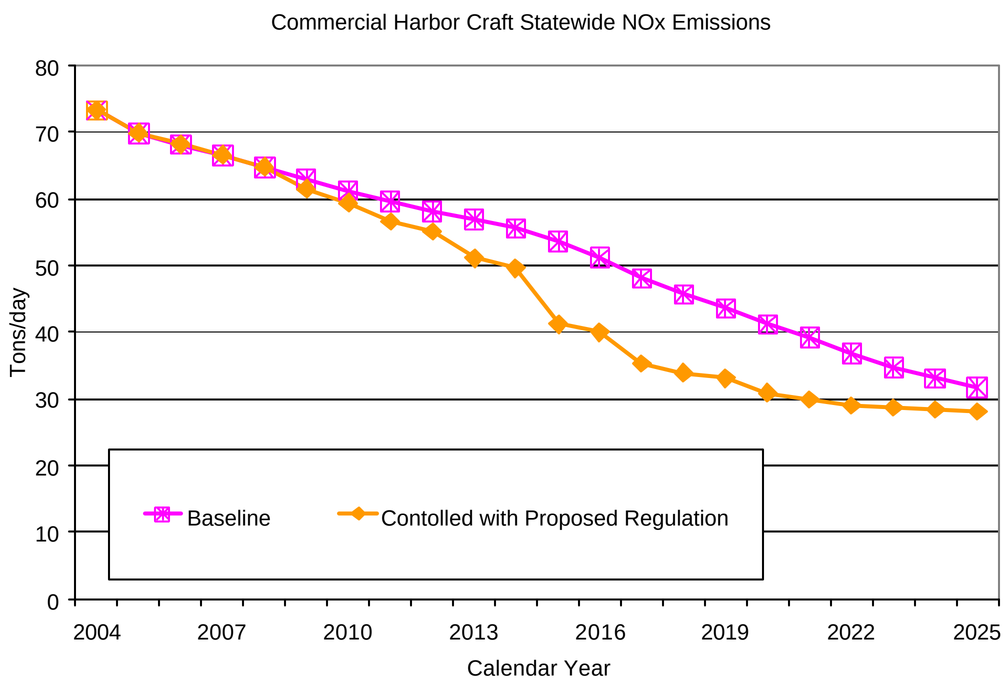


Figure VII-2: Projected NOx Emissions With and Without the Proposed Regulation



Between 2009 and 2022, we estimate approximately 2,400 tons of diesel PM and 39,000 tons of NOx will be removed from California's air as a result of the regulation, as shown in Table VII-4.

Table VII-4: Emission Benefits from Implementation of the Proposed Regulation

	PM	NOx
Emissions Reduced 2009 to 2022 (tons)	2,400	38,950
Annual Average Reductions (tpy)	175	2,800

C. Health Benefits Analysis

1. Reduced Ambient Particulate Matter Levels

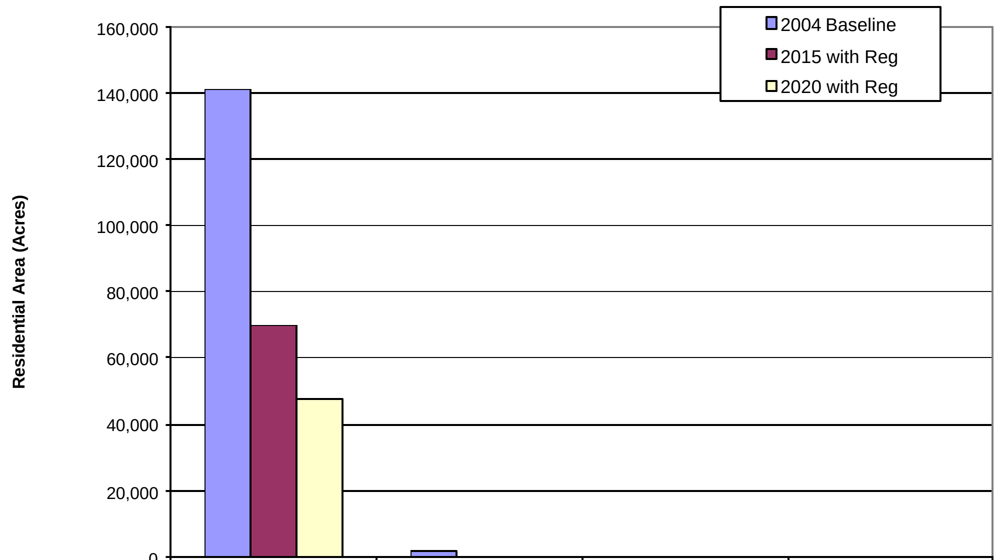
A substantial number of epidemiologic studies have found a strong association between exposure to ambient particulate matter (PM) and adverse health effects. (ARB, 2002) For this report, ARB staff evaluated the impacts the proposed regulation would have on potential cancer risks and conducted a quantitative analysis of seven potential non-cancer health impacts associated with exposures to ambient levels of directly emitted diesel PM.

a. Reduction in Potential Cancer Risks

The reductions in diesel PM emissions that will result from implementation of the proposed regulation will reduce the public's exposures to diesel PM emissions and the potential cancer risks associated with those exposures. The ARB staff used the air dispersion model and model inputs developed for the Port of Los Angeles (POLA) and Port of Long Beach (POLB) health risk assessment to estimate the reductions in potential cancer risk that would result from implementation of the proposed regulation in the area surrounding the two ports. Staff believes that the results from this analysis provide quantitative results for exposures around the POLA and POLB and are generally applicable to other ports in California, providing a qualitative estimate for those areas.

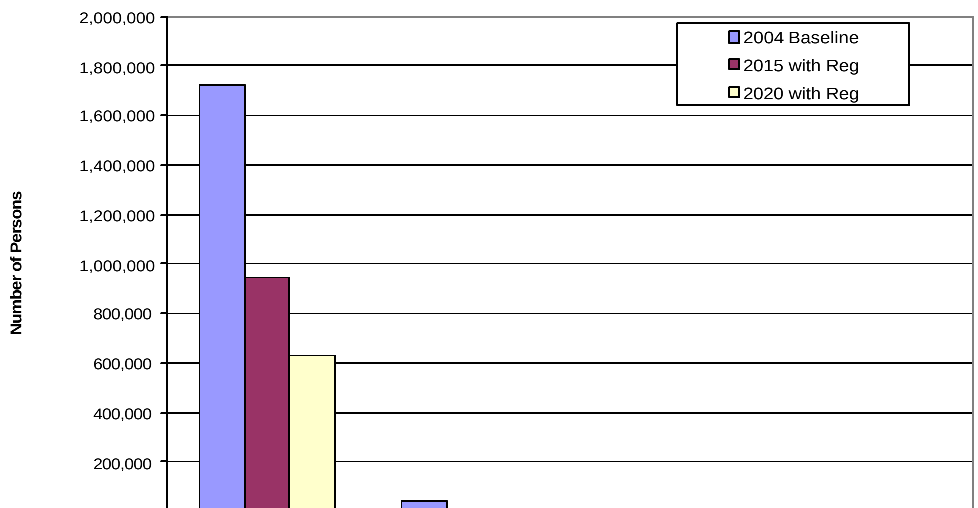
To investigate the reductions in potential risks that will result as emissions from harbor craft are reduced, ARB staff used dispersion modeling and the projected 2015 and 2020 emissions inventories to estimate the above ambient concentration of diesel PM emissions that result from the operation of harbor craft at the POLA and POLB in 2015 and 2020. The potential cancer risks from exposures to the projected 2015 and 2020 emissions were then estimated and compared to the 2002 levels to determine how the potential risks will change. As shown in Figures VII-3 and VII-4, we expect a significant decline in the number of people exposed to elevated risk levels from harbor craft emissions and the acres impacted as the proposed regulation is implemented. Based on our analysis, we estimate that in 2015 there will be a 50 percent reduction in the number of residential acres and population exposed to diesel PM concentrations greater than 10 per million, and a 65 percent reduction in 2020.

Figure VII-3: Residential Areas Impacted by the Proposed Regulation for Baseline Year (2004) and Projections for 2015 and 2020 at the POLA/LB



	Risk > 10	Risk > 100	Risk > 200	Risk > 500
2004 Baseline	140,790	1,977	89	0
2015 with Reg	69,703	69	0	0
2020 with Reg	47,869	0	0	0

Figure VII-4: Population Affected by the Proposed Regulation for Baseline Year (2004) and Projections for 2015 and 2020 at the POLA/LB



	Risk > 10	Risk > 100	Risk > 200	Risk > 500
2004 Baseline	1,722,364	44,155	7,651	0
2015 with Reg	943,280	6,267	0	0
2020 with Reg	629,594	0	0	0

b. Non-Cancer Health Impacts and Valuations

To determine the impacts from the proposed regulation on non-cancer health endpoints, ARB staff used the methodology described previously in Chapter III to evaluate the change in ambient PM levels that are expected due to implementation of the proposed regulation. This analysis shows that the statewide cumulative impacts of the emissions reduced through this regulation from year 2009 through 2025 are approximately:

- 310 premature deaths (90 to 530, 95% confidence interval (CI))
- 70 hospital admissions due to respiratory causes (40 to 90, 95% CI)
- 120 hospital admissions due to cardiovascular causes (80 to 190, 95% CI)
- 8,100 cases of asthma-related and other lower respiratory symptoms (3,100 to 13,000, 95% CI)
- 670 cases of acute bronchitis (0 to 1,500, 95% CI)
- 53,000 work loss days (45,000 to 61,000, 95% CI)
- 300,000 minor restricted activity days (250,000 to 360,000, 95% CI)

Table VII-5 lists the impacts associated with primary and secondary diesel emissions separately. The methodology for estimating these health impacts is outlined below and details can be found in Appendix A of the Emission Reduction Plan for Ports and Goods Movement in California (ARB, 2006) [9].

[9] http://www.arb.ca.gov/planning/gmerp/march21plan/appendix_a.pdf

Table VII-5: Total Health Benefits Associated with Reductions in Emissions from Commercial Harbor Craft (2009-2025)[A]

Endpoint	Pollutant	# of Cases 95% C.I. (Low)	# of Cases (Mean)	# of Cases 95% C.I. (High)
Premature Death	PM	50	200	340
	NOx	30	110	190
	Total	*90*	*310*	*530*
Hospital admissions (Respiratory)	PM	30	40	60
	NOx	20	20	30
	Total	*40*	*70*	*90*
Hospital admissions (Cardiovascular)	PM	50	80	120
	NOx	30	40	70
	Total	*80*	*120*	*190*
Asthma & Lower Respiratory Symptoms	PM	1,900	5,000	8,100
	NOx	1,200	3,100	4,900
	Total	*3,100*	*8,100*	*13,000*
Acute Bronchitis	PM	0	420	920
	NOx	0	250	540
	Total	*0*	*670*	*1,500*
Work Loss Days	PM	28,000	34,000	39,000
	NOx	16,000	19,000	22,000
	Total	*45,000*	*53,000*	*61,000*
Minor Restricted Activity Days	PM	160,000	190,000	230,000
	NOx	91,000	110,000	130,000
	Total	*250,000*	*300,000*	*360,000*

[A] Health effects from primary and secondary PM are labeled PM and NOx, respectively. The sum of PM and NOx impacts may not equal the total given due to rounding.

c. <u>Economic Valuation of Non-Cancer Health Effects</u>

The U.S. EPA has established $4.8 million in 1990 dollars at the 1990 income level as the mean value of avoiding one premature death. (EPA, 1999) This value is the mean estimate from five contingent valuation studies and 21 wage-risk studies. Contingent valuation and wage-risk studies examine the willingness to pay (or accept) for a minor decrease (or increase) in risk of premature death. For example, if 10,000 people are willing to pay $800 apiece for risk reduction of 1/10,000 then collectively the willingness-to-pay for avoiding a premature death, in this example, would be $8 million. This is also known as the “value of a statistical life” or VSL.[10]

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[10] U.S. EPA’s most recent regulatory impact analyses, (U.S. EPA 2004, 2005), apply a different VSL estimate ($5.5 million in 1999 dollars, with a 95 percent confidence interval between $1 million and $10 million). This revised value is based on more recent meta-analytical literature, and has not been endorsed by the Environmental Economics Advisory Committee (EEAC) of U.S. EPA’s Science Advisory Board (SAB). Until U.S. EPA’s SAB endorses a revised estimate, CARB staff continues to use the last VSL estimate endorsed by the SAB, i.e., $4.8 million in 1990 dollars.

As real income increases, people are willing to pay more to prevent premature death. U.S. EPA adjusts the 1990 value of avoiding a premature death by a factor of 1.201[11] to account for real income growth from 1990 through 2020. (EPA, 2004) Assuming that real income grows at a constant rate from 1990 until 2020, we adjusted VSL for real income growth, increasing it at a rate of approximately 0.6 percent per year. We also updated the value to 2006 dollars. After these adjustments, the value of avoiding one premature death is $8.2 million in 2006, $8.6 million in 2015 and $9.2 million in 2025, all expressed in 2006 dollars.

The U.S. EPA also uses the willingness-to-pay (WTP) methodology for some non-fatal health endpoints, including lower respiratory symptoms, acute bronchitis and minor restricted activity days. WTP values for these minor illnesses are also adjusted for anticipated income growth through 2025, although at a lower rate (about 0.2 percent per year in lieu of 0.6 percent per year).

For work-loss days, the U.S. EPA uses an estimate of the parent's lost wages, (EPA, 2004), which ARB adjusts for projected real income growth, at a rate of approximately 1.5 percent per year.

"The Economic Value of Respiratory and Cardiovascular Hospitalizations," (ARB, 2003), calculated the cost of both respiratory and cardiovascular hospital admissions in California as the cost of illness (COI) plus associated costs such as loss of time for work, recreation and household production. When adjusting these COI values for inflation, ARB uses the Consumer Price Index (CPI) for medical care rather than the CPI for all items.

Table VII-6 lists the valuation of avoiding various health effects, compiled from ARB and U.S. EPA publications, updated to 2006 dollars. The valuations based on WTP, as well as those based on wages, are adjusted for anticipated growth in real income.

[11] U.S. EPA's real income growth adjustment factor for premature death incorporates an elasticity estimate of 0.4.

Table VII-6: Undiscounted Unit Values for Health Effects (at various income levels in 2006 dollars) [A]

Health Endpoint	2006	2015	2025	References
Mortality				
Premature death ($ million)	8.2	8.6	9.2	U.S. EPA (1999, p. 70-72, 2000, (2004, p. 9-121)
Hospital Admissions				
Cardiovascular ($ thousands)	43	48	54	ARB (2003), p. 63
Respiratory ($ thousands)	35	39	44	ARB (2003), p. 63
Minor Illnesses				
Acute Bronchitis	451	459	469	U.S. EPA (2004), 9-158
Lower Respiratory Symptoms	20	20	21	U.S. EPA (2004), 9-158
Work loss day	189	217	252	2002 California wage data, U.S. Department of Labor
Minor restricted activity day (MRAD)	64	65	66	U.S. EPA (2004), 9-159

[A] The value for premature death is adjusted for projected real income growth, net of 0.4 elasticity. Wage-based values (Work Loss Days) are adjusted for projected real income growth, as are WTP-derived values (Lower Respiratory Symptoms, Acute Bronchitis, and MRADs). Health endpoint values based on cost-of-illness (Cardiovascular and Respiratory Hospitalizations) are adjusted for the amount by which projected CPI for Medical Care (hospitalization) exceeds all-item CPI.

Benefits from the proposed Commercial Harbor Craft Rule are substantial. The ARB staff estimates the benefits to be nearly $2.0 billion using a 3 percent discount rate or $1.3 billion using a 7 percent discount rate. (ARB follows U.S. EPA practice in reporting results using both 3 percent and 7 percent discount rates.) Nearly all of the monetized benefits result from avoiding premature death. The estimated benefits from avoided morbidity are less than $30 million with a 3 percent discount rate and less than $20 million with a 7 percent discount rate. Approximately three-fifths of the benefits are associated with reduced diesel PM, and the remaining two-fifths with reduced NOx.

2. Reduced Ambient Ozone Levels

Emissions of NOx and ROG are precursors to the formation of ozone in the lower atmosphere. Exhaust from diesel engines contributes a substantial fraction of ozone precursors in any metropolitan area. Therefore, reductions in NOx and ROG from diesel engines would make a considerable contribution to reducing exposures to ambient ozone. Controlling emissions of ozone precursors would reduce the prevalence of the types of respiratory problems associated with ozone exposure and would reduce hospital admissions and emergency visits for respiratory problems.

D. Reasonably Foreseeable Environmental Impacts as a Result of Potential Compliance Methods

The primary compliance strategy proposed in the regulation is accelerated engine replacement. The ARB staff anticipates that the majority of harbor craft owner/operators will choose to comply with the requirements of the proposed regulation using the repower strategy. Staff does not foresee any negative environmental impacts associated with the use of engine repowers as a primary strategy.

One compliance option with potential adverse environmental impacts is the use of diesel emission control strategies. To date, there are no ARB verified after-treatment controls for marine engines. As such, ARB is allowing the use of non-verified after-treatment control devices in the hope of achieving some reductions of diesel PM associated with harbor craft due to the installation of after-treatment controls. The ARB staff does not anticipate significant reductions of diesel PM from harbor craft attributable to after-treatment controls until such time as those technologies are proven to be effective and durable when used in the marine environment. The ARB continues to support projects that utilize after-treatment controls in the hope that those technologies will become verified in the future.

The ARB has identified potential adverse environmental impacts from the use of diesel oxidation catalysts (DOCs) and diesel particulate filters (DPFs). These include a potential increase in sulfate PM, a potential increase in nitrogen dioxide (NO2) from some DPFs, and the potential for creating hazardous wastes. As described below, options are available to mitigate these potential adverse impacts.

1. Diesel Oxidation Catalyst (DOC)

Two potential adverse environmental impacts of the use of DOCs have been identified. First, as is the case with most processes that incorporate catalytic oxidation, the formation of sulfates increases at higher temperatures. Depending on the exhaust temperature and sulfur content of the fuel, the increase in sulfate particles may offset the reductions in soluble organic fraction emissions. With the ARB requiring the use of ultra low sulfur diesel fuel (<15 ppm sulfur), this effect has been minimized, but still needs to be taken into account when considering whether or not to use a DOC as a preferred emission reduction strategy.

Second, a DOC could be considered a “hazardous waste” at the end of its useful life depending on the materials used in the catalytic coating. Because catalytic converters have been used on gasoline powered on-road vehicles for many years, there is a very well-established market for these items (see, for example, http://pacific.recycle.net – an Internet posting of buyers and sellers of various scrap materials). In the recycling process, the converters are broken down, and the metal is added to the scrap-metal stream for recycling, while the catalysts (one or a combination of the platinum group metals) are extracted and reused.

Because of platinum's high activity as an oxidation catalyst, it is the predominant platinum group metal used in the production of DOCs. There is a very active market for reclaimed platinum for use in new catalytic converters, jewelry, fuel cells, cathode ray tube screens, catalysts used during petroleum refining operations, dental alloys, oxygen sensors, platinum electrode spark plugs, medical equipment, and platinum-based drugs for cancer treatment, to name a few. (Kendall, 2002) (Kendall, 2003)

2. Catalyzed Diesel Particulate Filters

These devices are composed of a ceramic diesel particulate filter along with a platinum catalyst to catalyze the oxidation of carbon-containing emissions and significantly reduce diesel PM emissions. This is an obvious positive environmental impact.

However, there are also inorganic solid particles present in diesel exhaust, which are captured by diesel particulate filters. These inorganic materials are metals derived from engine oil, diesel fuel, or engine wear and tear. While the PM filter is capable of capturing inorganic materials, these materials are not oxidized into a gaseous form and expelled.

Because these materials would otherwise be released into the air, the filters are benefiting the environment by capturing these metallic particles, known as "ash." However, the ash that is collected in the PM filter must be removed from the filter periodically to maintain the filter's effectiveness.

Ash collected from a diesel engine using a typical lubrication oil and no fuel additives has been analyzed and is primarily composed of oxides of the following elements: calcium, zinc, phosphorus, silicon, sulfur, and iron. Zinc is the element of primary concern because, if present in high enough concentration, it can be considered a hazardous waste. Title 22, CCR, section 66261.24 establishes two limits for zinc in a waste: 250 milligrams per liter for the Soluble Threshold Limit Concentration and 5,000 milligrams per kilogram for the Total Threshold Limit Concentration. The presence of zinc at or above these levels would cause a sample of ash to be characterized as a hazardous waste.

Under California law, it is the generator's responsibility to determine whether their waste is hazardous or not. Applicable hazardous waste laws are found in the HSC, division 20; title 22, CCR, division 4.5; and title 40 of the Code of Federal Regulations. Staff recommends owners that install a diesel particulate filter on an engine to contact both the manufacturer of the diesel emission control system and the California Department of Toxic Substances Control (DTSC) for advice on proper waste management.

The ARB staff has consulted with personnel of the DTSC regarding management of the ash from diesel particulate filters. The DTSC personnel have advised ARB that it has a list of facilities that accept waste from businesses that qualify as a conditionally exempt small quantity generator. Such a business can dispose of a specific quantify of hazardous waste at certain Household Hazardous Waste events, usually for a small fee. An owner who does not know whether or not he qualifies or who needs specific information regarding the identification and acceptable disposal methods for this waste should contact the California DTSC.[12]

Additionally, the technology exists to reclaim zinc from waste. For example, the Swedish company MEAB has developed processes for extracting zinc and cadmium from various effluents and industrial waste streams. Whether reclamation for reuse will be economically beneficial remains to be seen. (MEAB, 2003)

Because of the time and costs associated with filter maintenance, there are also efforts by industry to reduce the amount of ash formed. Most of the ash is formed from the inorganic materials in engine oil, particularly from zinc-containing additives necessary to control acidification of engine oil – due in part to sulfuric acid derived from sulfur in diesel fuel. As the sulfur content of diesel fuel is decreased, the need for acid neutralizing additives in engine oil should also decrease. A number of technical programs are ongoing to determine the impact of changes in oil ash content and other characteristics of engine oil on exhaust emission control technologies and engine wear and performance.

It may also be possible to reduce the ash level in diesel exhaust by reducing oil consumption from diesel engines. Diesel engine manufacturers over the years have reduced engine oil consumption in order to reduce PM emissions and to reduce operating costs for engine owners. Further improvements in oil consumption may be possible in order to reduce ash accumulation rates in diesel particulate filters.

In addition, measurements of NOx emissions for heavy-duty diesel vehicles equipped with passive catalyzed filters have shown an increase in the NO2 portion of total NOx emissions, although the total NOx emissions remain approximately the same. In some applications, passive catalyzed filters can promote the conversion of nitrogen oxide (NO) emissions to NO2 during filter regeneration. More NO2 is created than is actually being used in the regeneration process; and the excess is emitted. The NO2 to NOx ratios could range from 20 to 70 percent, depending on factors such as the diesel particulate filter systems, the sulfur level in the diesel fuel, and the duty cycle. (DaMassa, 2002)

Formation of NO2 is a concern because it irritates the lungs and lowers resistance to respiratory infections. Individuals with respiratory problems, such as asthma, are more susceptible to the effects. In young children, nitrogen dioxide may also impair lung development. In addition, a higher NO2/NOx ratio in the exhaust could potentially result in higher initial NO2 concentrations in the atmosphere which, in turn, could result in higher ozone concentrations.

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[12] Information can be obtained from local duty officers and from the DTSC web site at http://www.dtsc.ca.gov.

Model simulations have shown that a NO_2 to NO_x emission ratio of approximately 20 percent would nearly eliminate any impact of increased NO_2 emissions. (DaMassa, 2002). According to the model, at the NO_2 to NO_x ratio of 20 percent, there will be a decrease of the 24-hour ozone exposure (greater than 90 parts per billion) by two percent while an increase of the peak 1-hour NO_2 by six percent (which is still within the NO_2 standard).

The health benefits derived from the use of PM filters are immediate and offset the possible adverse effects of increases in NO_2 emissions. For this reason, a cap of 20 percent NO_2 to NO_x emission ratio was established for all diesel emission control systems through ARB's Verification Procedure.

3. Alternative Fuels

As discussed in Appendix E, a number of alternative fuels and alternative diesel fuels show great promise in their potential to reduce diesel PM emissions. These include alternative diesel fuels such as biodiesel, emulsified diesel fuel, and Fischer-Tropsch fuels, and alternative fuels such as natural gas. No significant negative environmental impacts have been determined from the use of alternative fuels. With respect to alternative diesel fuels, there may be a slight increase in NO_x emissions as a result of biodiesel use. (Hofman and Solseng, 2002)

To ensure that there are no adverse impacts from the use of alternative diesel fuels, the proposed regulation requires any alternative diesel-fuel or fuel additives used in a harbor craft engine meet the following requirements:

a) be CARB diesel fuel; or
b) an "alternative diesel fuel" as defined in subsection (d)(2) of the proposed regulatory language; or
c) any alternative diesel fuel that does not meet subsection (d)(2) of the proposed regulatory language, but is certified by ARB as meeting the requirements of the Verification Procedure; or
d) CARB diesel fuel used with fuel additives that meets the requirements of the Verification Procedure; or
e) any combination of alternative fuels described above.

The Verification Procedure permits verification only if a multimedia evaluation of the use of the alternative diesel fuel or additive has been conducted. In addition, verification requires a determination by the California Environmental Policy Council that such use will not cause a significant adverse impact on public health or the environment pursuant to HSC section 43830.8 (see Public Resource Code, section 71017).

E. Reasonably Foreseeable Mitigation Measures

The ARB staff has concluded that no significant adverse environmental impacts should occur from adoption of and compliance with the proposed regulation. Therefore, no mitigation measures would be necessary.

F. Reasonably Foreseeable Alternative Means of Compliance with the Proposed Regulation

Alternative means to comply with the proposed regulation are provided through the availability to submit Alternative Compliance Plans, the use of diesel emission control strategies to achieve the same emission reductions that would be achieved through engine replacement, demonstrating that the engine in question already meets the most current U.S. EPA marine engine emission standards, or if the vessel owner/operator has rebuilt the engine to meet the most current U.S. EPA marine engine emission standards.

Although there are issues associated with the use of alternative diesel emission control strategies to achieve reductions of emissions of NOx and diesel PM from harbor craft, ARB staff believes that there are ways to address and mitigate any adverse environmental impacts associated with a specific emission control strategy.

Two of the alternative compliance strategies described above, use of aftertreatment diesel emission control strategies and engine rebuilds, provide limited benefits associated with the reduction of NOx and diesel PM from harbor craft and delay final compliance with the proposed regulation. These compliance options are needed because they provide the regulated community with some flexibility for compliance with the proposed regulation. These options also promote the development of cleaner retrofit and rebuild technologies for harbor craft.

G. Impact on Global Warming

Global warming is the process whereby emissions from anthropogenic sources, together with naturally-occurring gases, absorb infrared radiation in the atmosphere, leading to an increase in ambient temperatures world-wide. Compounds that potentially contribute to global warming include six substances identified in the Kyoto Protocol. These substances are: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride (SF_6). These substances are all gases that have long lifetimes in the atmosphere, anywhere from a year to several thousand years depending on the gas.

Climate research has identified other chemical species that also have potential to alter the Earth's climate. These other chemical species, which have much shorter atmospheric lifetimes than CO_2 (several days, or less, depending on the chemical species), have not been directly included in climate change-related emission reduction efforts due to the scientific uncertainty of their magnitude of potential climate changing impacts.

The chemical species not cited in the Kyoto Protocol are primarily anthropogenic pollutants emitted principally as by-products of fossil fuel and biomass combustion. One of the confounding aspects associated with these non-Kyoto chemical species is the scientific community's uncertainty as to whether some of these chemical species have a warming or cooling effect on the world-wide climate. The chemical species thought to result in net warming include carbon monoxide (CO), volatile organic compounds, hydrogen (H_2), and the black carbon fraction of particulate matter (PM). With the exception of PM, the potential net warming effect of these chemical species is the result of the formation of tropospheric ozone (O_3) and methane. Two non-Kyoto chemical species that may have a net cooling effect are NOx and sulfur dioxide (SO_2).

Typically, Global Warming Potential (GWP) the metric used to compare the relative significance of pollutants with respect to their impacts on global warming. The GWP of a specific substance is a measure of the additional amount of heat trapped in the atmosphere when one kilogram of that substance is instantaneously released to the atmosphere, relative to the instantaneous release of one kilogram of CO_2. A GWP is calculated using computer models that incorporate the radiative heat balance of the atmosphere and the chemical kinetics of all the substances involved. The atmosphere is assumed to be in a steady-state when the GWP of a substance is modeled. Changes in atmospheric temperature are modeled based on the introduction of a kilogram of a potential global warming substance.

The primary strategy employed by the proposed harbor craft regulation focuses on the replacement of older, dirtier, unregulated and Tier 1 engines with cleaner Tier 2 engines. Many of the engines being replaced are 2-stroke engines with mechanical controls. These engines will be replaced with electronically controlled 4-stroke engines. These electronically controlled 4-stroke engines are smaller, lighter, less polluting, and should reduce green house gases compared to the older, in-use engines, including a reduction in emissions of black carbon (a component of diesel PM and a likely contributor to global warming).

Conversely, the additional emission control requirement for new-build ferries may result in slightly increased carbon dioxide (CO_2) for some applications. This may occur, for example, if vessel operators choose to comply with the regulations by using exhaust treatment technologies that use vessel power (e.g., scrubbers, selective catalytic reduction), increase the weight of the vessel, increase the engine back pressure, or require a larger engine to be installed on the vessel.

Taking into account both the green house gas reductions of the newer engines and the increases associated with new-build ferries, the overall impact of the regulation on global warming is expected to be negligible.

REFERENCES:

(ARB, 2000) Air Resources Board. *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles*. http://www.arb.ca.gov/diesel/documents/rrpapp.htm; October 2000.

(ARB, 2002) Air Resources Board and Office of Environmental Health Hazard Assessment. *Public Hearing to Consider Amendments to the Ambient Air Quality Standards for Particulate Matter and Sulfates, Staff Report*. http://www.arb.ca.gov/research/aaqs/std-rs/pm-final/pm-final.htm; May 2002.

(ARB, 2003) Air Resources Board. May 2003. Final Research Report: The Economic Value of Respiratory and Cardiovascular Hospitalizations. ftp://ftp.arb.ca.gov/carbis/research/apr/past/99-329.pdf

(ARB, 2006) California Air Resources Board. *Emission Reduction Plan for Ports and Goods Movement in California*; April 2004.

(DaMassa, 2002) DaMassa, John. California Air Resources Board. *Presentation: Air Quality Effects of Trap-Related Emissions (Updated)*; February 6, 2002.

(Kendall, 2002) Kendall, Tom; Johnson Matthey. *Platinum 2002*; http://www.platinum.matthey.com/publications/1051543656.html; May 2002.

(Kendall, 2003) Kendall, Tom; Johnson Matthey. *Platinum 2003*; http://www.platinum.matthey.com/publications/1059138410.html; May 2003.

(MEAB, 2003) Metallextraktion AB (MEAB). *http://www.meab-mx.se/en/index.htm*; August 2003.

(Krewski et al., 2000) Krewski D.; Burnett R.; Goldberg M.; Hoover K.; Stemiatychi J.; Jerrett M.; Abrahamovicz M.; White W. Health Effects Institute, Cambridge, Massachusetts. *Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality*. http://es.epa.gov/ncer/science/pm/hei/Rean-ExecSumm.pdf; 2000.

(Lloyd and Cackette, 2001) Lloyd, A.C.; Cackette, T.A.; J Air Waste Management Assoc. *Diesel Engines: Environmental Impact and Control*;., 51:809-847. http://www.arb.ca.gov/research/seminars/lloyd/AWMA2001/JAWMADieselCriticalReview.pdf; 2001.

(EPA, 1999) United States Environmental Protection Agency. *The Benefits and Costs of the Clean Air Act 1990 to 2010*. EPA-410-R-99-001. http://www.epa.gov/air/sect812/copy99.html; November 1999.

(EPA, 2000) United States Environmental Protection Agency., *Guidelines for Preparing Economic Analyses.* EPA240-R-00-003. http://www.epa.gov/opei/pubsinfo.htm; September 2000.

(EPA, 2003) United States Environmental Protection Agency, Assessment and Standards Division, Office of Transportation and Air Quality. *Draft Regulatory Impact Analysis: Control of Emissions of Air Pollution from Nonroad Diesel Engines and Fuel*. EPA420-R-03-008. CD-ROM. Research Triangle Park, North Carolina. http://www.epa.gov/otaq/cleaner-nonroad/r03008.pdf; April 2003.

(EPA, 2004) United States Environmental Protection Agency. May, 2004. Final Regulatory Impact Analysis: Control of Emissions from Nonroad Diesel Engines. EPA-420-R-04-007. Office of Transportation and Air Quality. http://www.epa.gov/otaq/regs/nonroad/equip-hd/2004fr.htm#ria

VIII. ECONOMIC IMPACTS

In this chapter, the estimated costs and economic impacts associated with implementation of the proposed regulation for commercial harbor craft are presented. The expected capital and recurring costs for potential compliance options, the cost and associated economic impacts on businesses, as well as an analysis of the cost-effectiveness of the proposed regulation are presented.

A. Summary of the Economic Impacts

In assessing the costs associated with the proposed regulation, ARB staff developed two different estimates, one for "regulatory costs" and another for "new equipment costs." Regulatory costs are the estimated costs resulting from the proposed regulations taking into consideration the residual value of the in-use engine being replaced, the residual value of the most recent engine rebuild work, aftertreatment costs for new ferries, recordkeeping and reporting costs, and the time value of money associated with the early engine replacement. New equipment costs are the estimated total out-of-pocket costs for purchasing and installing a new engine (engine replacement cost) in ferries, excursion vessels, tugboat s, and towboats; new ferry aftertreatment costs; and recordkeeping and reporting costs.

Staff estimates the lifetime regulatory cost for complying with the proposed regulation to be approximately $140 million (2006 dollars). This corresponds to about $10 million annually from 2009 through 2022. New equipment costs are estimated at approximately $460 million dollars (2006 dollars) over the lifetime of the proposed regulation (2009 to 2022). The portion of new equipment costs for purchasing and installing a new engine are costs that the vessel owner would eventually pay, but the proposed regulation requires this service to be performed earlier than normal.

Staff evaluated the economic impacts of the proposed regulation by estimating the effect of the regulatory cost on the "return on owner's equity" (ROE) for a typical business.

Using the ROE approach, we found that the overall change in ROE would range from a negligible decline of about 0.5 percent for a typical tow company, to a slightly more significant decline of 3.5 percent for a ferry/excursion vessel or tug company assuming affected businesses absorb the entire regulation costs. Staff's analysis indicates that the change in ROE could be larger for small businesses. However, in most cases, ferry, tug, and tow businesses provide a needed service that is not easily replaced and they will likely be able to raise their fees to pay for the temporary increase in costs. Additionally, businesses with compliance dates at least three years in the future may be eligible for incentive grant funds if they choose to comply early. Overall, most affected businesses will be able to absorb the costs of the proposed regulation with no significant adverse impacts on their profitability.

Multiple federal, State, and local agencies will be impacted by the proposed regulation. The majority of the agencies not be affected by the in-use compliance requirements and will only be subject to the reporting requirement, resulting in costs of approximately $100 per engine. One State agency, the California Department of Transportation (Caltrans) and three local agencies which operate passenger ferries would be impacted by the in-use engine requirements. Regulatory costs to these agencies range from about $2,000 to $2 million. There would be significant costs to the ARB to implement and enforce the regulation. Staff estimates that ARB's cost to implement the reporting program (initial report) would be approximately $25 to $50 per engine. An additional annual cost of $10 to $100 per engine (after the first year) is estimated to cover an inspection and report update at the time of final compliance with the regulation. It was assumed that each engine would be inspected once. These total costs are estimated to be $200,000 to $600,000 for the regulation. The ARB's administrative costs for outreach, educational efforts, and technical assistance would be absorbed within existing budgets and resources.

Cost-effectiveness is expressed in terms of costs in dollars per unit of emissions reduced (pounds or tons). The cost-effectiveness for the proposed regulation is determined by dividing the regulatory costs by the total pounds of diesel PM reduced during the years 2009 to 2022. All costs are in 2006 equivalent expenditure dollars. Table VIII-1 shows the cost-effectiveness estimate for the proposed regulation expressed three ways. The cost-effectiveness values are well within the range of cost effectiveness for other diesel engine regulations adopted by the Board.

Table VIII-1: Summary of Average Cost Effectiveness for the Period 2009-2022

Emissions	Total Regulatory Cost 2009 – 2022	Total Emissions Reduced 2009 - 2022	Total Cost-Effectiveness
All costs assigned to PM			
PM	$140,000,000	4,900,000 lbs	$29/lb
Divide Costs Equally Between PM and NOx			
PM	$70,000,000	4,900,000 lbs	$14.50/lb
NOx	$70,000,000	39,000 tons	$1,800/ton
Combine PM and NOx Emissions			
PM + NOx	$140,000,000	83,000,000 lbs	$1.70/lb

All values rounded

The estimated value of the health benefits associated with the proposed regulation is substantial. Staff estimates the statewide benefits to be nearly $2.0 billion using a 3 percent discount rate or $1.3 billion using a 7 percent discount rate. (ARB follows U.S. EPA practice in reporting results using both 3 percent and 7 percent discount rates.) Nearly all of the monetized benefits result from avoiding premature death.

B. Legal Requirements

In this section, the legal requirements that must be satisfied in analyzing the economic impacts of the regulation are explained.

Section 11346.3 of the Government Code requires State agencies to assess the potential for adverse economic impacts on California business enterprises and individuals when proposing to adopt or amend any administrative regulation. The assessment shall include a consideration of the impact of the proposed regulation on California jobs, business expansion, elimination or creation, and the ability of California business to compete with businesses in other states. Also, State agencies are required to estimate the cost or savings to any State or local agency in accordance with instructions adopted by the Department of Finance (DOF). The estimate shall include any non-discretionary cost or savings to local agencies and the cost or savings in federal funding to the State.

In addition, Health and Safety Code section 57005 requires the ARB to perform an economic impact analysis of submitted alternatives to a proposed regulation before adopting any major regulation. A major regulation is defined as a regulation that will have a potential cost to California business enterprises in an amount exceeding ten million dollars. Because the estimated cost of the regulation does exceed 10 million dollars, an economic analysis of submitted alternatives to the proposal was conducted.

The following is a description of the methodology used to estimate costs as well as ARB staff's analysis of the economic impacts on California businesses and State and local agencies.

C. Methodology for Estimating Costs Associated with Proposed Regulation

In this section, the estimated costs associated with the proposed regulation are discussed.

Briefly, the methodology entailed:

- Two different estimates of costs were developed, regulatory costs and new equipment costs.
    - The regulatory costs are the estimated costs resulting from the proposed regulations taking into consideration the residual value of the in-use engine being replaced, the residual value of the most recent engine rebuild work, aftertreatment costs for new ferries, recordkeeping and reporting costs, and the time value of money associated with the early engine replacement.
    - New equipment costs are the estimated total out-of-pocket costs for purchasing and installing a new engine (engine replacement cost), new ferry aftertreatment costs, and recordkeeping and reporting costs. The portion of new equipment out-of-pocket costs for purchasing and installing a new engine are costs that the vessel owner would eventually pay, but

the proposed regulation requires this service to be performed earlier than normal.

- Engine replacement (repowering) was the assumed in-use engine compliance option.
- Operating and maintenance costs for replacement engines were assumed to be the same as for an existing engine and were not included.
- The 2004 emissions inventory was projected to future years to determine the number of pre-2008 engines remaining that would need to be replaced each year and the number of new vessels added to the fleet each year.
- Aftertreatment costs for new ferries include equipment costs and estimated maintenance costs for PM controls.
- Reporting costs were estimated at about $100 per engine per report.
- Costs were estimated in 2006 dollars.

Based on the ARB Survey and updated emissions inventory, there are an estimated 300 private ferry, excursion vessel, tugboat , and towboat companies operating about 670 harbor craft with over 1,900 diesel engines that will have to meet new engine standards. The regulatory and new equipment costs will vary depending on the number of harbor craft a company operates and the option chosen to comply with the proposed regulation. Vessel categories other than ferry, excursion vessel, tugboat , and towboat, will incur only minor costs associated with monitoring (hour meter), recordkeeping, and reporting requirements.

1. Costs

a. <u>Engine Replacement (Repower) Costs:</u>

The estimated costs for purchasing and installing a new diesel-fueled engine in an in-use harbor craft were determined using actual cost data from the Moyer Program submittals and cost information provided by the San Francisco Bay Area Water Transit Authority (WTA) and the Golden Gate Ferry. Staff's estimate of the average costs per engine horsepower for purchase and installation of a new main and auxiliary diesel-fueled engine are shown in Table VIII-2.

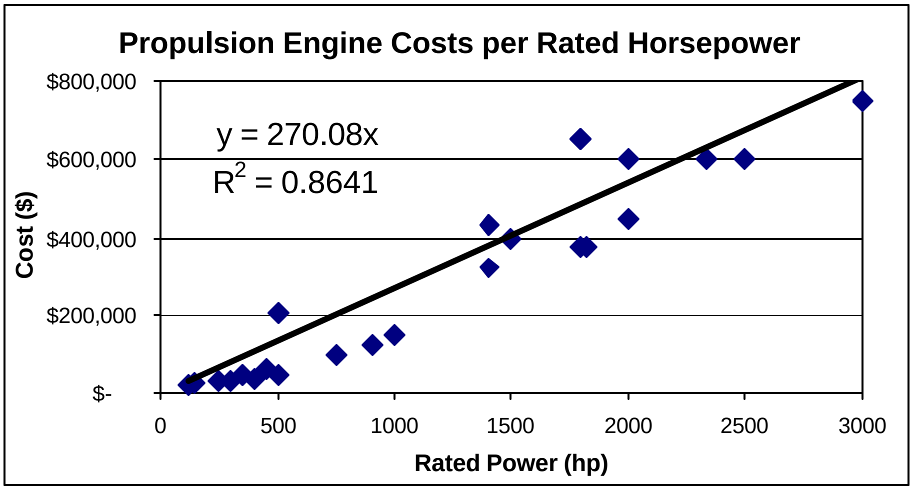
Table VIII-2: Estimated Engine Replacement Costs

Engine Category	Average Cost ($/hp)[A]
Propulsion Replacement	$ 270
Auxiliary Replacement	$ 233

[A] Includes engine, labor, and ancillary equipment costs.

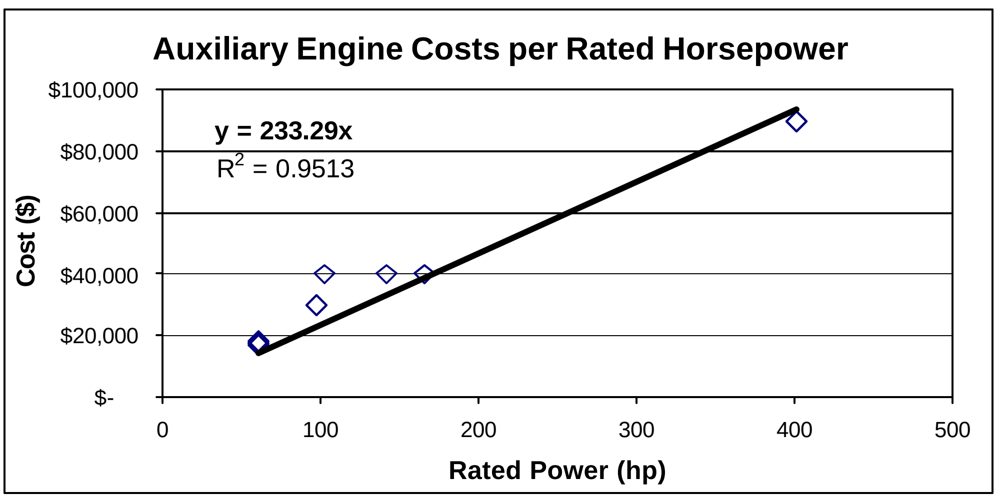
Figure VIII-1 and Figure VIII-2 provide the technical basis for the engine replacement cost estimates in Table VIII-2. These figures show the relationship between engine replacement costs and horsepower. Staff plotted engine costs versus the horsepower and the resulting linear equations for main and auxiliary engines are shown in the two figures. For main engines, the estimated cost is 270 times the engine horsepower. For auxiliary engines, the estimated cost is 233 times the engine horsepower. These relationships were used to estimate engine replacement costs for the proposed regulation. Engine costs were assumed to increase by 20 percent after 2013 when U.S. EPA marine engine Tier 3 standards come into effect for the majority of the engines. (EMA French)

Figure VIII-1: Propulsion Engine Cost vs. Horsepower[A]



[A] Includes engine, labor, and ancillary equipment costs.

Figure VIII-2: Auxiliary Engine Cost vs. Horsepower[A]



[A] Includes engine, labor, and ancillary equipment costs.

b. Early Replacement Costs

(i) Residual Value of Engine

Staff anticipates that most operators of ferries, excursion vessel, tugboat s, and towboats will comply with the proposed regulation by replacing existing engines with new engines. There will be situations where engines will have to be replaced before the end of the engine's useful service life. In these situations, the costs associated with the loss of the residual or remaining value of the engine being replaced is assigned to this regulatory action. In situations where the engine is being replaced after the end of the useful service life, costs associated with the engine replacement are not assigned to the regulation.

We have used the following two equations to calculate remaining or residual value for main and auxiliary engines.

RV_M = [$270 * Hp] * [1 – EA/USL] *Note: applicable only when EA/UEL < 1*.

Where:

RV_M is the remaining or residual value of the main engine
Hp is the rated horsepower of the main engine(s)
EA is the engine age in years
USL is the useful service life (see Table VIII-3)

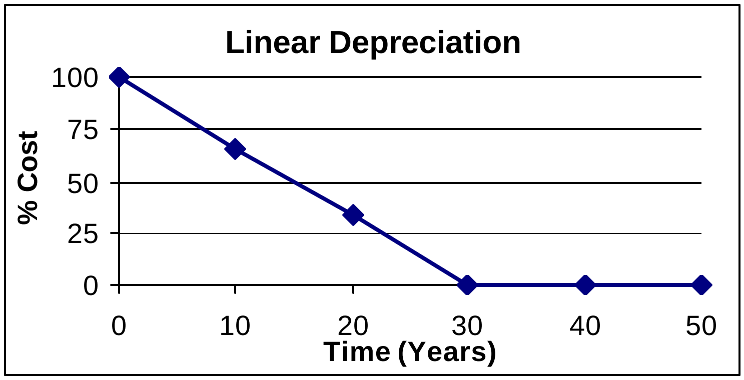
RV_A = [$233 * Hp] * [1 – EA/USL] *Note: applicable only when EA/UEL < 1*

Where:

RV_A is the remaining or residual value of the auxiliary engine
Hp is the rated horsepower of the auxiliary engine(s)
EA is the engine age in years
USL is the useful service life (see Table VIII-3)

The cost associated with early engine replacement was determined by estimating the remaining residual value of the engine at the time it is required to be replaced. To determine this we assumed a linear depreciation of the engine's value such that the remaining (residual) value is zero at the end of the engines useful service life. A graph of linear depreciation with an engine with a 30 year useful service life is presented in Figure VIII-3.

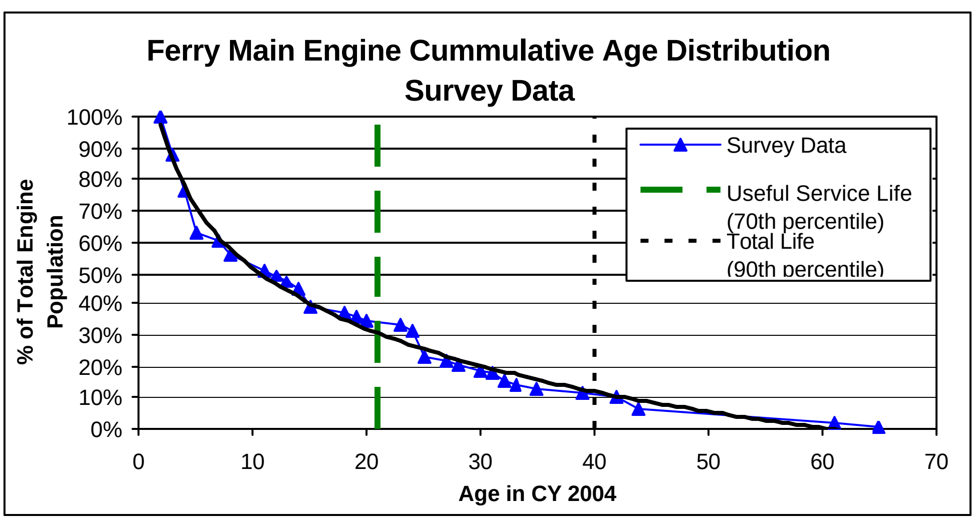
Figure VIII-3: Linear Depreciation Example for Residual Value



For this analysis, we have defined the useful service life for harbor craft engines to be the 70th percentile engine age on the cumulative engine age distribution curve. In other words, the engine age (years old) where 70 percent of the engines are younger than this age and 30 percent of the engines are older than this age. In Figure VIII-4, the survey ferry/excursion vessel main engine age distribution is shown along with the age distribution trend line to smooth out and approximate the statewide population trend.

The 70th percentile was chosen instead of the typical 50th percentile because recent Carl Moyer program funding for engine replacements and growth of the industries have resulted in a skewing of the age distribution toward more new engines. Choosing the 70th percentile provided an economic service life that was close to half the total life, which is similar to the ideal distribution curve where half the engines are gone by half the total life.

Figure VIII-4: Ferry/Excursion Main Engine Population Distribution



The total life was chosen in a similar fashion, but the 90th percentile engine age was used. In other words, the engine age (years old) where 90 percent of the engines are younger than this age and 10 percent of the engines are older than this age. The 90th percentile age was selected because some engines are kept for an extremely long time, usually as a spare or backup with very little use, and would skew the typical total life. In the ferry/excursion vessel main engine survey population, a couple engines are older than 60 years and extend the age beyond what would be considered normal. The trend line crosses the 10 percent of total population grid line (90th percentile) at about an age of 40 years and establishes the expected total life of ferry/excursion vessel main engines.

Table VIII-3 presents ARB estimates of the useful service life and total life for main and auxiliary engine on ferries, tugboat, and towboats.

Table VIII-3: Estimated Useful Service and Total Life of Used Equipment

Vessel Engine Type	Useful Service Life	Total Life
Ferry/Excursion Main	21	40
Ferry/Excurasion Auxiliary	20	40
Tugboat Main	25	42
Tugboat Auxiliary	30	45
Towboat Main	34	60
Towboat Auxiliary	35	50

For all of the cost calculations, we assumed that the value of an engine at the end of its useful service life was $0 or equal to the removal costs. Presented below is an example calculation of the residual value for a main engine in a tugboat with a 15-year-old 1500 hp main engine that is replaced 10 years before the end of its useful service life of 25 years.

$$\text{Main Engine Residual Value} = [\$270 \times 1500] \times \left[1 - \frac{15 \text{ years}}{25 \text{ years/total life}}\right] = \$162{,}000$$

For this tugboat main engine, the portion of the regulatory cost based on the residual main engine costs attributed to compliance with the proposed regulation would be $162,000.

(ii) Residual Value of Engine Rebuild Work

As with the previous section and discussion of the residual value of the engine, there is also a residual value to the most recent engine rebuilds or overhauls. The engine overhauls are categorized as either a “major” or “top end” overhaul. The frequency of these overhauls can depend on the engine application and the amount of annual use. Engines used under high loads and long hours may need to be overhauled more often.

Most of the ferries, excursion vessels, towboats, and tugboat s appear to have a similar overhaul frequency.

Based on the information received on engine overhauls, the overhaul frequency is typically around every 10 years for a major overhaul and 5 years for a top end overhaul. For this cost analysis, staff assumed a major overhaul and top end overhaul schedule of 10 and 5 years, respectively. There will be situations where engines will have to be replaced before the end of the engine's expected overhaul life. In these situations, the costs associated with the loss of the residual or remaining value of the engine overhaul when the engine is being replaced is assigned to this regulatory action. In situations where the engine is being replaced at the end of the overhaul life, costs associated with the engine overhaul are not assigned to the regulation.

Staff used the residual value of major and top end engine overhauls as one of the costs associated with early engine replacement. To determine this we assumed a linear depreciation of the overhaul's value such that the remaining (residual) value is zero at the end of the overhaul's useful service life. Staff gathered overhaul cost information for many engines by contacting owners of boat maintenance and repair facilities. Using this information we developed the following two equations to calculate remaining or residual value for major and top end engine overhauls. These equations apply to both the main and auxiliary engines.

OV_M = [$53.93 * Hp +$13641] * [1 – MOA/MOL]

Note: applicable only when MOA/MOL < 1.

Where:

OV_M is the remaining or residual value of the major engine overhaul
Hp is the rated horsepower of the main engine(s)
MOA is the major overhaul age in years
MOL is the major overhaul life (assume 10 years)

OV_T = [$16.52 * Hp + $12456] * [1 – TOA/TOL]

Note: applicable only when TOA/TOL < 1

Where:

OV_T is the remaining or residual value of the top end overhaul
Hp is the rated horsepower of the auxiliary engine(s)
TOA is the top end overhaul age in years
TOL is the top end overhaul life (assume 5 years)

c. Fuel Costs

Fuel costs were not included in this analysis. We anticipate a net fuel savings of 3 to 5 percent with new engines due to both the electronic engine controls and the lighter weight. The slightly lighter new engines produce similar power as the engines being replaced and this lighter weight translates into less fuel consumed while traveling through the water at a similar vessel speed. Also, since the new engines will be electronically controlled, we anticipate fuel savings due to more efficient fuel combustion. Fuel costs for new ferries with BACT installed were also not taken into account. The added weight and increased back pressure of exhaust emission control technologies would increase fuel consumption. Data from the Baylink Vallejo Ferry with SCR installed indicates that this increase could be as much as 10 percent. However, the number of new ferries added to the fleet in the next 14 years will be small compared to the number of Tier 0 and Tier 1 engines repowered with more fuel efficient engines.

d. Out of service costs

"Out-of-service" costs can occur when a vessel is removed from service to replace an engine(s). Changing out a main engine takes about two to three weeks. Since most ferries, tugboat s, and towboats have two propulsion engines, these vessels would be out-of-service for 4 to 6 weeks. Staff has not assigned an out-of-service cost for the regulation. We assumed that engine replacement for excursion vessels would occur during their low use season and not have an impact on revenue. For transit ferries, tugboat s, and towboats, we assumed that most companies have sufficient excess capacity to schedule engine replacements so as to maintain the current level of service and minimize the "out-of-service" cost. An additional factor we considered is that companies currently, as a normal business practice, take the vessels out of service every five years for an engine overhaul. We believe that the out of service time for a repower would replace the out of service time for an overhaul.

e. Operation and Maintenance Costs – Replacement Engines

Based on discussion with engine manufacturers, we do not anticipate that there will be any change in the operating and maintenance costs for new engines compared to the engines that are being replaced.

f. New Ferry Aftertreatment Costs

The proposed regulation requires that new ferries install BACT to further reduce emissions. Staff estimated the cost for aftertreatment system for a new ferry vessel to be $170 per engine horsepower. This cost estimate assumes that BACT is likely to be a combined PM and NOx system. As such, the $170/hp represents the combination of the current cost of a selective catalytic reduction system (SCR) of approximately $125/hp and the cost of a diesel particulate filter (DPF) of approximately $45/hp. By selecting a combined cost of these two emission reduction systems, staff ensured that the cost of aftertreatment system was not underestimated. It should be noted that while staff is assuming a combined SCR/DPF system, the actual determination of what BACT would be used will be made on a case-by-case basis. Depending on the specifics, BACT may be a PM control system, a NOx control system, or a combination PM/NOx system.

The installation of aftertreatment systems on new ferries would generate additional operating and maintenance costs for these vessels. The additional maintenance costs would be cleaning, refurbishing, and periodically replacing the aftertreatment system. Additional operating costs would include additional fuel usage due to the added weight of the system and increased back pressure to the engine and the cost of urea for an SCR system. These costs depend on the technologies used. Staff assumed a DPF cleaning cost of $300 per year and a replacement cost of $170/hp every 5 years which includes replacement of both DPF and SCR. A 5 year replacement period was based on an average annual engine usage of about 1600 hours and a life of twice the typical 4200 hour warranty period. These costs were calculated for 2009 through 2022 and included as regulatory costs.

The major operating cost for a SCR system is the urea costs. Staff estimated a nominal urea cost at about $15,000 per year or a total of about $200,000 over the 2009 through 2022 time frame. We have not included these costs in our calculation of regulatory costs due to uncertainty in what technology will be selected, the actual cost of operating the system, and the limited number of new ferries anticipated over the life of the regulation.

g. Monitoring, Recordkeeping, and Reporting Costs

Monitoring cost are the costs associated with the installation of a non-resettable engine hour meter that is required by the proposed regulation. An hour meter is standard equipment on all new engines and has been for some time. Therefore, we assumed no one time or recurring cost for this equipment. Reporting costs for compliance with the recordkeeping and reporting requirements in the proposed regulation was assumed to be $100 per engine during the first year of the regulation. Staff estimated approximately one hour would be needed to collect and send this information at a pay rate of $100 per hour. The ARB staff believes this is a conservative assumption since many companies already keep these records. Reporting costs of $100 per engine were also included for when a ferry, excursion vessel, tugboat, or towboat engine would be brought into compliance. Annual reporting is not required; however, there are occasions specified in the propose regulation when reporting would be required. These include the purchase of a new engine or vessel, change in engine or vessel ownership, and change in engine operating hours.

2. Future Year Equipment Populations Subject to the Regulatory Requirements

Staff estimated the engine inventory for future years to determine the number of in-use engines required to come into compliance in each year. The development of this inventory is discussed in Chapter III, Harbor Craft Inventory and Emissions, and Appendix B. Staff has used the inventory and emissions model to calculate equipment growth, annual use, age distribution, and attrition for the vessel categories. Future year equipment populations for each compliance year were evaluated by the inventory model to determine the number of engines to be replaced for each compliance year.
Table VIII-4 presents the expected number of in-use engines per year required to comply with the requirements of the regulation.

The numbers of new ferry propulsion engines required to comply with the BACT requirement were estimated using the model based on population growth rates. These are also included in Table VIII-4. These numbers are likely to be over-estimated due to a current limitation of the model. The ferry and excursion vessel categories were combined in the model because separate data for these two categories were not available. So, while the requirement that propulsion engines on new ferries have BACT installed on them does not apply to excursion vessels, or ferries that carry less than 75 passengers, it was not possible to separate out these vessels with the current model.

Staff know of only four new ferries (total of eight propulsion engines), either built or planned to be built in the 2004 to 2009 time frame. This indicates that at least half to three-fourths of the new ferry engines shown in Table VIII-4 are actually excursion vessel engines not subject to the BACT requirement. The initial reporting required by the proposed regulation would help staff separate these categories for the future model.

Table VIII-4: Estimated Population of In-Use Vessel Engines and New Ferry Engines Subject to Regulation Emission Limits

Year	Number of In-Use Engines			Number of New Ferry Engines
	Auxiliary	**Propulsion**	**Total**	**Propulsion**
2009	38	102	140	7
2010	111	132	243	8
2011	29	24	53	8
2012	23	48	71	7
2013	45	83	128	5
2014	29	40	69	5
2015	53	149	203	3
2016	39	23	62	4
2017	54	113	166	4
2018	54	113	167	4
2019	55	113	168	4
2020	56	113	169	4
2021	47	42	88	4
2022	28	34	63	4
Total	**662**	**1,127**	**1,789**	**72**

D. Total Regulatory and New Equipment Costs

Table VIII-5 provides the regulatory costs attributed to the in-use engine requirements of the proposed regulation. The in-use engine regulatory costs are derived from the residual value of the replaced engine, the residual value of the most recent overhaul, the time value of money for the earlier than anticipated repower cost, and the reporting cost. The first year reporting costs include the cost to all harbor craft operators to provide equipment and operating information to ARB. Subsequent year reporting costs include the cost of updating the initial information as engines are replaced. The in-use vessel total regulatory costs for this regulation over the years 2009 to 2022 are estimated to be $123 million. Approximately 57 percent of the total in-use regulatory cost is from the ferry and excursion vessels, 36 percent from tugboats, and 7 percent from towboats.

Table VIII-5: Estimated Regulatory Costs for In-Use Engine Replacement

Year	Regulatory Costs		
	Auxiliary	Main	Total
2009	$615,000	$2,063,000	$3,510,000
2010	$416,000	$1,138,000	$1,555,000
2011	$364,000	$1,131,000	$1,495,000
2012	$371,000	$1,864,000	$2,234,000
2013	$923,000	$10,526,000	$11,449,000
2014	$565,000	$5,372,000	$5,937,000
2015	$1,330,000	$23,451,000	$24,782,000
2016	$751,000	$2,014,000	$2,765,000
2017	$928,000	$15,696,000	$16,623,000
2018	$944,000	$14,453,000	$15,397,000
2019	$960,000	$13,210,000	$14,170,000
2020	$976,000	$11,967,000	$12,943,000
2021	$732,000	$4,894,000	$5,626,000
2022	$477,000	$4,075,000	$4,551,000
Total	**$10,352,000**	**$111,854,000**	**$123,038,000**

Table VIII-6 provides summaries of the new equipment compliance costs for the replacement of in-use engines with new engines. The in-use engine new equipment costs are derived from the capital and installation repowers costs and the reporting cost. The new equipment costs for repowering an in-use engine are costs that the vessel owner would eventually pay, but the proposed regulation requires this service to be performed earlier than normal. The first year reporting costs include the cost for all harbor craft to provide equipment and operating information to ARB. Subsequent year reporting costs include the cost of updating the initial information as engines are replaced. The total in-use engine replacement new equipment costs associated with this regulation over the years 2009 to 2022 are estimated to be $441 million. Approximately 68 percent of the total in-use new equipment cost is incurred by the ferry and excursion vessel industry, 27 percent by the tugboat industry, and 5 percent by towboat industry.

Table VIII-6: Estimated New Equipment Costs for In-Use Engine Replacement

Year	New Equipment Costs		
	Auxiliary	Main	Total
2009	$792,000	$17,199,000	$17,991,000
2010	$2,146,000	$14,219,000	$16,366,000
2011	$773,000	$8,540,000	$9,313,000
2012	$622,000	$8,353,000	$8,975,000
2013	$1,395,000	$35,559,000	$36,954,000
2014	$1,098,000	$19,116,000	$20,214,000
2015	$1,795,000	$76,689,000	$78,484,000
2016	$1,147,000	$6,067,000	$7,214,000
2017	$1,719,000	$63,411,000	$65,130,000
2018	$1,781,000	$55,595,000	$57,376,000
2019	$1,842,000	$47,780,000	$49,622,000
2020	$1,903,000	$39,964,000	$41,868,000
2021	$1,600,000	$15,958,000	$17,558,000
2022	$999,000	$13,270,000	$14,269,000
Total	**$19,612,000**	**$421,721,000**	**$441,333,000**

Table VIII-7 provides the estimated numbers of the new ferry engines in each year (2009-2022) and the resulting costs due to compliance with the BACT requirement of the proposed regulation. The regulatory costs and the new equipment costs are the same for this requirement. These costs are based on the cost of installing both a DPF and an SCR, periodic replacement cost, an estimated annual operating cost for a diesel PM emission control system, and a reporting cost. As mentioned earlier, these costs do not include the ongoing costs for operating an SCR system.

Table VIII-7: Population and Costs for New Ferry Propulsion Engines with Aftertreatment

Year	Number of Propulsion Engines	Regulatory and New Equipment Costs
2009	7	$942,000
2010	8	$1,079,000
2011	8	$1,055,000
2012	7	$907,000
2013	5	$726,000
2014	5	$1,605,000
2015	3	$1,495,000
2016	4	$1,553,000
2017	4	$1,480,000
2018	4	$1,204,000
2019	4	$1,204,000
2020	4	$982,000
2021	4	$1,053,000
2022	4	$1,120,000
Total	**72**	**$16,406,000**

Total Estimated Capital and Recurring Costs 2009-2022

The total regulatory and new equipment costs for compliance with the proposed regulation were estimated using the cost estimates outlined previously. The total annual regulatory and new equipment costs for the vessel engines and emission controls are provided in Table VIII-8 and Table VIII-9. As shown in Table VIII-8, the regulatory costs associated with the proposed regulation are about $140 million and range from $2.5 to $26 million per year with an average annual cost of $10 million. As shown in Table VIII-9, the new equipment costs associated with the propose regulation are about $458 million and range from $9 to $80 million with an average annual cost of about $33 million. Approximately 70 percent of the total new equipment cost is incurred by the ferry and excursion vessel industry, 25 percent by the tugboat industry, and 5 percent by towboat industry.

Table VIII-8: Summary of Estimated Total Regulatory Costs for Proposed Harbor Craft Regulation

Year	Regulatory Cost		
	Auxiliary	Main	Total
2009	$615,000	$3,006,000	$4,452,000
2010	$416,000	$2,218,000	$2,634,000
2011	$364,000	$2,187,000	$2,551,000
2012	$371,000	$2,771,000	$3,142,000
2013	$923,000	$11,252,000	$12,175,000
2014	$565,000	$6,977,000	$7,543,000
2015	$1,330,000	$24,947,000	$26,277,000
2016	$751,000	$3,568,000	$4,319,000
2017	$928,000	$17,176,000	$18,103,000
2018	$944,000	$15,767,000	$16,711,000
2019	$960,000	$14,359,000	$15,319,000
2020	$976,000	$12,950,000	$13,926,000
2021	$732,000	$5,947,000	$6,679,000
2022	$477,000	$5,195,000	$5,672,000
Total	**$10,352,000**	**$128,320,000**	**$139,504,000**

Table VIII-9: Summary of Estimated Total New Equipment Costs for Proposed Harbor Craft Regulation

Year	New Equipment Costs		
	Auxiliary	Main	Total
2009	$792,000	$18,141,000	$18,933,000
2010	$2,146,000	$15,299,000	$17,445,000
2011	$773,000	$9,596,000	$10,369,000
2012	$622,000	$9,261,000	$9,883,000
2013	$1,395,000	$36,286,000	$37,681,000
2014	$1,098,000	$20,721,000	$21,819,000
2015	$1,795,000	$78,184,000	$79,980,000
2016	$1,147,000	$7,621,000	$8,768,000
2017	$1,719,000	$64,891,000	$66,610,000
2018	$1,781,000	$56,909,000	$58,690,000
2019	$1,842,000	$48,928,000	$50,770,000
2020	$1,903,000	$40,947,000	$42,850,000
2021	$1,600,000	$17,011,000	$18,611,000
2022	$999,000	$14,391,000	$15,390,000
Total	**$19,612,000**	**$438,187,000**	**$457,799,000**

E. Estimated Costs to Businesses

The costs and economic impacts on businesses are presented in this section. The overall impact on business competitiveness, employment, and other impacts on business are also presented.

1. Potential Business Impacts Based on Change to ROE

Staff's analysis of the potential impacts of the proposed regulation on businesses in California was based on a comparison of the ROE for affected businesses before and after the inclusion of the regulatory costs. The analysis used publicly available information to assess the impacts on competitiveness, jobs, and business expansion, elimination, or creation. From the limited financial data staff obtained on ferry, excursion vessel, tugboat, and towboat owners, none of these companies would be considered a small business bases on the definition of a small business per California Government Code Section 11342.610 (annual gross receipts of $1,500,000 or less for transportation and warehousing). There may be some ferry, excursion vessel, tugboat, and towboat vessel owners that could be considered a small business, but ARB was unable to identify them due to a lack of financial data. Staff expects that tugboat and towboat businesses would not be considered a small business and within the ferry and excursion businesses, only the smaller excursion vessel business may fall into that classification.

The types of businesses that the proposed regulation will have an economic impact on are those that own ferries, excursion vessels, tugboats, and towboats. Other types of businesses that will be slightly impacted by the reporting cost requirements are businesses that own commercial fishing, charter, work, pilot, crew and supply vessels and other commercial harbor craft. Based on the ARB Survey, staff estimates that there are approximately 300 ferry, excursion vessel, tugboat, and towboat businesses that will be affected by this regulation beyond simply complying with the reporting requirements.

The ROE approach used in evaluating the potential economic impact of the proposed regulation on California businesses is as follows:

(1) Affected businesses were identified from responses to the ARB survey. ARB staff selected a total of nine companies with some financial data, three companies from each affected type of business representing ferry/excursion vessel, tugboat, and towboat.

(2) The cost for compliance was estimated and averaged over the years a particular company was affected.

(3) The total annual cost for each business was adjusted for both federal and states taxes.

(4) These adjusted costs were subtracted from net profit data, either actual net profit from Dun and Bradstreet or industry averages applied to the number of employees, and the results used to calculate the Return on Owners' Equity (ROE). The resulting ROE was then compared with the ROE before the subtraction of the adjusted costs to determine the impact on the profitability of the businesses.

Using Dun and Bradstreet financial data when data were available, staff calculated the ROEs, both before and after the subtraction of the adjusted annual costs, for the typical businesses from each industry category. These calculations were based on the following assumptions.

- A selected business in each category of ferry/excursion, tugboat, and towboat is representative of a typical business in that category.
- All affected businesses are subject to federal and state tax rates of 35 percent and 9.3 percent, respectively.
- Affected businesses are neither able to increase the prices of their services nor lower their costs of doing business through cost-cutting measures.

These assumptions, though reasonable, might not be applicable to all affected businesses.

As shown in Table VIII-10, the average ROE of the sample businesses in the categories listed changed by about 2.5 percent. The decline in profitability was highest for ferries/excursion vessels and tugboats (3.4 percent and 3.6 percent) and lowest for towboats (0.5 percent). These businesses, however, are unlikely to have to absorb the entire cost of this regulation. To the extent that they are able to pass on the cost of the regulation, the impact on their profitability would be less than estimated here. Thus, staff expects most affected businesses to be able to absorb the cost of the regulation with no significant impact on their profitability. However, it is likely that some small businesses may be affected significantly. The change in ROE is expected to be larger for small businesses, especially ferries and excursion.

Table VIII-10: Typical Affected Businesses with Change in ROE

Category	ROE % Change
Ferry/Excursion	-3.4%
Tugboat	-3.6%
Towboat	-0.5%
Average	-2.5%

These businesses may be able to reduce the impact of the regulation on their businesses by taking advantage of available public funding. The costs impacts presented here do not taken into consideration the impact of incentive or grant funding. Publicly owned ferries are often eligible for both State and Federal transportation related grants. Moyer Program funding is a potential funding source for companies that comply early or achieve emission reductions beyond the regulation. We also anticipate Bond Funds to be available for goods movement related vessels like tugboats and towboats.

2. Potential Impact on Employment, Business Creation, Elimination or Expansion

a. Potential Impact on Employment

The proposed regulation is not expected to cause a noticeable change in California employment and payroll. According to the 2005 Economic Census, California employment in the inland water transportation industry (NAICS 48321), which includes establishments engaged in providing inland water transportation of passengers and/or cargo on lakes, rivers, or intra-coastal waterways) was 519 in 2005, or about 10 percent of the employment in the water transportation industry. This also represents only about 0.1 percent of the total transportation and warehousing jobs in California. These employees working in 33 establishments generated about $23 million in payroll, accounting for about 0.1 percent of total California transportation and warehousing payroll in 2005. Sixty establishments had 20 employees or more; the rest had less than 20 employees each.

The employment in the inland water transportation industry is unlikely to change significantly as a result of the proposed regulation. This is because most affected businesses are likely to be able to pass on the regulation cost to their customers in terms of higher service fees. The staff's profitability analysis shows that the impact on business profitability is minor even if the affected businesses absorb the entire cost of the proposed regulation.

The proposed regulation, however, is likely to increase employment in businesses that make, sell, install and maintain marine engines and DPF and SCR devices.

b. Potential Impact on Business Creation, Elimination or Expansion

The proposed regulation would have no noticeable impact on the status of California businesses. This is because the regulation costs are not expected to impose a significant impact on the profitability of businesses in California. However, some small businesses with little or no margin of profitability may lack the financial resources to comply in a timely manner. These businesses may be able to take advantage of available public funding such as Carl Moyer program to ameliorate the impact of the proposed.

While some individual businesses may be affected adversely, the proposed regulation may provide business opportunities for existing California businesses or result in the creation of new businesses. California businesses that make, install, and service marine engines and DPF and SCR devices to affected harbor craft businesses may benefit from increased harbor craft business spending on compliance.

c. Potential Impact on Business Competitiveness

The proposed regulation would have no significant impact on the ability of California businesses to compete with businesses in other states. Because ferries, tugboats and towboats operate locally and are not subject to competition from similar businesses operating out-of state.

F. Potential Costs to Local, State, and Federal Agencies

This proposed regulation directly affects local, State, or Federal agencies. It will result in increased costs for those public agencies that own ferries, excursion vessels, tugboats, or towboats. Those public agencies owning or operating harbor craft other than ferries, excursion vessels, tugboats, or towboats, will have an insignificant cost impact to comply with the proposed regulation. The calculated costs are shown in Table VIII-11. In this table, the “Regulatory Costs” and “Reporting Costs” are attributed to the regulation. The “New Equipment Costs” are, as discussed earlier, the total out-of-pocket cost for purchasing and installing the replacement engine. There would be significant costs to the ARB to implement and enforce the regulation. Staff estimates that ARB’s cost to implement the reporting program (initial report) would be approximately $25 to $50 per engine. An additional annual cost of $10 to $100 per engine (after the first year) is estimated to cover an inspection and report update at the time of final compliance with the regulation. These total costs are estimated to be $200,000 to $600,000 for the regulation. The ARB’s administrative costs for outreach, educational efforts, and technical assistance would be absorbed within existing budgets and resources.

Table VIII-11: Costs to Local, State, and Federal Agencies

Area	Agency	Regulatory Costs	New Equipment Out-of-Pocket Total	# of Engines Reporting	Reporting Cost
Federal	U.S. Dept. of Commerce / CINMS			5	$500
	U.S. National Park Service			1	$100
	Total			**6**	**$600**
Local	City of Alameda			8	$800
	City of Long Beach			9	$900
	City of Los Angeles			3	$300
	City of Oakland			3	$300
	City of Vallejo			4	$400
	City of Vallejo / Blue & White Fleet	$814,894	$6,288,150	12	$1,200
	Golden Gate Bridge Hwy Transportation Dist.	$2,350,830	$10,459,107	28	$2,800
	Mt. Diablo Unified School District			3	$300
	Port of Los Angeles	$37,063	$91,108	28	$2,800
	San Joaquin Co.			6	$600
	Santa Cruz Port Dist.			1	$100
	Total	**$3,202,787**	**$16,838,365**	**105**	**$10,500**
State	CA Dept. of Transportation		$183,725	24	$2,400
	CA. Dept. of Fish & Game			8	$800
	San Francisco State University			2	$200
	San Jose State University			4	$400
	State of CA, Parks Department			5	$500
	Total		**$183,725**	**43**	**$4,300**

G. Cost-Effectiveness

In this section, the cost-effectiveness of the regulation is estimated. Cost-effectiveness is expressed in terms of control costs (dollars) per unit of air emissions reduced (tons or pounds). As described below, for example, the cost-effectiveness for the proposed regulation is determined by dividing the total cost of the proposed regulation by the total pounds of diesel PM emissions reduced during the years 2009 to 2022. All costs are in 2006 equivalent expenditure dollars.

1. Expected Emission Reductions

Staff estimated the projected total emission reductions under the regulation using the statewide inventory. The following Table VIII-12 provides a summary of the annual statewide diesel PM and NOx reductions that will result from the proposed regulation. This regulation is expected to reduce almost 5 million pounds of diesel PM and 39 thousand tons of NOx by 2022. Table VIII-13 provides a breakdown of the annual statewide diesel PM and NOx reductions by vessel type that will result from the proposed regulation.

Table VIII-12: Statewide Diesel PM and NOx Annual Emission Reductions from 2009 to 2022

Year	PM Reduction (pounds/year)			NOx Reduction (tons/year)		
	Aux	Main	Total	Aux	Main	Total
2009	1,600	57,600	59,200	11	514	525
2010	2,800	68,600	71,400	22	637	659
2011	6,700	104,100	110,800	57	1,029	1,085
2012	6,800	102,700	109,500	58	1,032	1,090
2013	8,300	210,900	219,200	67	2,060	2,127
2014	8,800	228,800	237,600	70	2,096	2,166
2015	12,200	494,600	506,800	88	4,413	4,501
2016	12,400	458,900	471,300	86	3,973	4,059
2017	15,100	562,000	577,100	93	4,580	4,672
2018	14,400	536,500	550,900	86	4,200	4,285
2019	13,500	501,000	514,500	77	3,765	3,843
2020	12,600	509,300	521,900	68	3,668	3,735
2021	10,800	480,600	491,400	53	3,340	3,393
2022	9,200	415,600	424,800	40	2,774	2,814
Total	**135,200**	**4,731,200**	**4,866,400**	**876**	**38,078**	**38,955**

Table VIII-13: Statewide Diesel PM and NOx Annual Emission Reductions by Vessel Type

Year	Ferries		Towboats		Tugboats	
	PM (lbs/yr)	NOx (tons/yr)	PM (lbs/yr)	NOx (tons/yr)	PM (lbs/yr)	NOx (tons/yr)
2009	11,500	100	11,200	94	36,500	330
2010	12,500	120	13,400	110	45,400	430
2011	21,500	220	13,800	120	75,400	750
2012	24,300	250	12,700	110	72,600	730
2013	102,300	980	11,900	110	105,000	1,040
2014	126,200	1,100	10,200	94	101,200	980
2015	290,400	2,500	50,400	470	166,100	1,560
2016	267,000	2,200	47,700	440	156,600	1,440
2017	355,000	2,700	52,100	460	170,000	1,500
2018	334,000	2,400	50,800	440	166,100	1,420
2019	317,500	2,200	50,600	440	146,400	1,190
2020	331,900	2,300	58,500	490	131,600	970
2021	309,300	2,100	59,400	490	122,700	840
2022	256,500	1,600	58,100	470	110,300	730
Total	**2,759,900**	**20,770**	**500,800**	**4,338**	**1,605,900**	**13,910**

Note: Slight difference between Table VIII-12 and Table VIII-13 emissions totals are due to rounding.

2. Cost-Effectiveness

To determine the cost-effectiveness of the proposed regulation, the sum of the annual costs (2009 to 2022) for the proposed regulation were divided by the diesel PM emission reductions over the same time period attributable to the regulation. The summed 2009 to 2022 costs are based on the regulatory costs. The regulatory costs include the remaining value of the engine being replaced (engine, supporting equipment, and installation labor), the residual value of the most recent maintenance, emission control devices on new ferry main engines, and recordkeeping and reporting. The estimated overall cost-effectiveness (total PM reduced divided by total regulatory costs) is $29 per pound of diesel PM reduced, if all the costs of compliance are allocated to diesel PM reduction.

Since the regulation will also result in reductions in oxides of nitrogen (NOx) emissions, staff conducted a second cost-effectiveness analysis in which half of the cost of compliance was allocated to PM benefits and half the cost was allocated to NOx benefits. This results in cost-effectiveness values of $14.50/lb diesel PM and $1,800/ton of NOx.

A third method to express cost effectiveness is to use the sum of the combined PM and NOx reductions (approximately 83 million pounds). Using this approach, the resulting cost effectiveness for the proposed regulation is about $1.70 per pound of PM and NOx reduced. These cost-effectiveness values are presented in Table VIII-14.

Table VIII-14: Summary of Average Cost-Effectiveness for the Period 2009-2022

Emissions	Total Regulatory Cost 2009 – 2022	Total Emissions Reduced 2009 - 2022	Total Cost-Effectiveness
All costs assigned to PM			
PM	$140,000,000	4,900,000 lbs	$29/lb
Divide Costs Equally Between PM and NOx			
PM	$70,000,000	4,900,000 lbs	$14.50/lb
NOx	$70,000,000	39,000 tons	$1,800/ton
Combine PM and NOx Emissions			
PM + NOx	$140,000,000	83,000,000 lbs	$1.70/lb

All values rounded

As shown in Table VIII-15, the cost-effectiveness of the proposed regulation is in the range of other regulations recently adopted by the Board. For example, the diesel PM cost-effectiveness of the solid waste collection vehicle rule was estimated at $28 per pound, excluding the benefits of NOx and hydrocarbon reductions (ARB, 2003a). The cost-effectiveness of the stationary diesel engine airborne toxic control measure (ATCM) was estimated to range from $4 to $26 per pound of diesel PM reduced (ARB,2003b). Finally, the transport refrigeration unit ATCM was estimated to have a cost-effectiveness of $10 to $20 per pound of diesel PM reduced (ARB, 2003c).

Table VIII-15: Diesel PM Cost-Effectiveness of the Proposal and Other Regulations/Measures (Attributes All Costs to Each Pollutant Individually)

Regulation or Airborne Toxic Control Measure	Diesel PM Cost-Effectiveness
	Dollars/ Pound PM
Commercial Harbor Craft	$29
In-Use Off-Road Diesel Vehicles	$40
Cargo Handling Equipment Proposal	$41
Solid Waste Collection Vehicle Rule	$28
Stationary Diesel Engine ATCM	$4 - $26
Transport Refrigeration Unit ATCM	$10 - $20

H. Availability of Incentive Funding

Incentive programs have the ability to achieve emissions reductions early or beyond those required by regulations. California has one of the largest clean air incentive programs in the nation – the Carl Moyer Program – with up to $140 million available each year through State and local funds.

Even so, this level of funding is far from sufficient to pay for all the reductions needed to provide clean air. Reductions required by regulations, and funded by owners of the affected vehicles and equipment, must continue to provide the majority of emission reductions. Incentive programs, such as the Carl Moyer Program, fund the incremental cost of cleaner-than-required engines, equipment, and other sources of pollution providing early or extra emission reductions. Carl Moyer Program emission reductions are credited in California's State Implementation Plan and must be real, surplus to regulatory requirements, quantifiable, and enforceable.

The Carl Moyer Program is implemented as a partnership between ARB and the local air districts. The ARB provides program oversight and minimum program requirements and the local air districts select and fund projects. Statewide, the Carl Moyer Program has been oversubscribed every year, and this continues to be the case today. Eligible marine vessel projects compete with on-road, off-road, agricultural pump, locomotive, and other projects for funding.

Since its inception, the Carl Moyer Program has provided significant funding to replace older, high-emitting harbor craft engines with newer, cleaner engines. Most funding has gone towards fishing vessels, followed by tugboats, and ferry and excursion vessels. Fishing vessel grants have averaged about $35,000 per engine repower, while tugboat and ferry/excursion vessel grants have averaged about $93,000 and $125,000 per engine repower, respectively. Marine vessel repowers through the Carl Moyer program have been very cost-effective, averaging about $1,800 per ton of NOx reduced, with a typical project life of over ten years.

To date, no retrofit devices (such as diesel particulate filters) have been ARB- or U.S. EPA-verified to reduce emissions from marine vessels. For this reason, these devices for use on harbor craft are not yet eligible for Carl Moyer Program funds. Similarly, new harbor craft have not received program funding since only vessels certified to be at least 30 percent cleaner for NOx emissions than existing (Tier 2) U.S. EPA marine engine standards are eligible for funding, and no vessels have been certified as such to date. If a vessel were to be ARB- or U.S. EPA-certified to this cleaner-than-required emission rate, it would potentially be eligible for Carl Moyer Program funding.

The Carl Moyer Program has a minimum three year project life, meaning that incentive funds cannot be used to pay for a project within three years of its compliance deadline. Therefore, vessel engines with earlier compliance dates will have limited opportunity for funding. Regulated vessel engines with later compliance dates have a longer window of eligibility for funding. Engine repowers on vessels not subject to the in-use engine compliance requirements of the proposed regulation -- including fishing vessels, crew and supply vessels, work vessels, and others – continue to provide surplus emission reductions and remain eligible for Carl Moyer Program funds.

The proposed commercial harbor craft regulation has differing implementation timelines for vessels with homeport in the SCAQMD and those outside of the SCAQMD. Table VIII-16 and Table VIII-17 summarize the date by which commercial harbor craft projects must be complete to be eligible for Carl Moyer Program funding in both of these areas. In the case of engine repowers, the Moyer Project Completion Deadline reflects the date by which the new vessel engine must be installed and operational. In addition, project life for an engine cannot extend beyond that engines compliance deadline. For example, a 1980 model year engine operating 750 hours annually that is installed in December 2008 has a compliance deadline of December 31, 2012 and therefore would have a maximum project life of four years.

Table VIII-16: Carl Moyer Program Project Completion Deadline for In-Use Ferries, Excursion Vessels, Tugboats, and Towboats, Except those with Homeport in the SCAQMD

Engine Model Year	Total Annual Hours of Operation	Proposed Rule Compliance Deadline	Moyer Project Completion Deadline
Pre-1975	=1500	12/31/2009	No funds available
Pre-1975	300-1500	12/31/2010	12/31/2007
1976-1985	= 1500	12/31/2011	12/31/2008
1976-1985	300-1500	12/31/2012	12/31/2009
1986-1995	= 1500	12/31/2013	12/31/2010
1986-1995	300-1500	12/31/2014	12/31/2011
1996-2000	= 1500	12/31/2015	12/31/2012
1996-2000	300-1500	12/31/2016	12/31/2013
2001-2002	= 300	12/31/2017	12/31/2014
2003+	=300	12/31/2018	12/31/2015

These tables reflect requirements for ferries, excursion vessels, tugboats, and towboats only. As mentioned earlier, the proposed regulation does not require other vessels to reduce emissions; other vessels therefore continue to provide surplus emission reductions and are potentially eligible for Carl Moyer Program funding.

Table VIII-17: Carl Moyer Program Project Completion Deadline for In-Use Ferries, Excursion Vessels, Tugboats, and Towboats with Homeport in the SCAQMD

Engine Model Year	Proposed Rule Compliance Date	Moyer Project Completion Deadline
Pre-1979	12/31/2009	No funds available
1980-1985	12/31/2010	12/31/2007
1986-1990	12/31/2011	12/31/2008
1991-1995	12/31/2012	12/31/2009
1996-2000	12/31/2013	12/31/2010
2001	12/31/2014	12/31/2011
2002	12/31/2015	12/31/2012
2003	12/31/2016	12/31/2013
2004	12/31/2017	12/31/2014
2005	12/31/2018	12/31/2015

Since State law requires Carl Moyer Program emission reductions be real, quantifiable, enforceable, and surplus to regulatory requirements, the following criteria apply to engines subject to the proposed rule:

- Harbor craft engines receiving a rule compliance extension are ineligible for Carl Moyer Program funding during the compliance extension period.
- Harbor craft engines demonstrating compliance with the regulation through an Alternative Control of Emissions (ACE) are ineligible for Carl Moyer Program funding.
- Engines that demonstrate rule compliance through a mechanism other than engine replacement or installation of an ARB- or U.S. EPA-verified retrofit device are not eligible for Carl Moyer Program funding.
- To ensure project eligibility is not based on a Carl Moyer Program-funded compliance extension, vessel engines rebuilt to a Tier 1 or cleaner emission standard with Carl Moyer Program funds prior to January 1, 2008 shall use the engine date (rather than the date of remanufacture) to determine funding eligibility and project life.
- Barges which are not self-propelled are not considered a ‘mobile source’ and are therefore ineligible for Carl Moyer Program funding.

In November 2006, California voters approved $1 billion in incentive funding to reduce emissions from goods movement activities (Proposition 1B). Enabling legislation is required before these funds can be made available to ARB, and may provide additional direction regarding fund project categories and funding recipients. Bond funding directed to commercial harbor craft could impact when and how Carl Moyer Program funds are made available to avoid overlap between potentially similar incentive programs.

I. Analysis of Alternatives

In this section, the cost-effectiveness of the proposed regulation is compared to two alternative control options. Both alternatives use a single in-use compliance schedule for the entire state. The first alternative analyzed would bring all in-use harbor craft engines into compliance on the proposed statewide schedule. The other alternative is to use the proposed accelerated SCAQMD compliance schedule for the entire state. The first alternative results in a slightly lower regulatory cost, but does not provide the needed early emissions reductions for the SCAQMD. The second alternative would achieve greater emission reductions and associated health benefits. However, the cost of this alternative would be higher and it would present a problem with the ability of the State's existing boat building, repair, and yard facilities to absorb the increased work load. The cost effectiveness of all three options are very similar.

Alternative 1: Remove the SCAQMD Accelerated Compliance and Require the SCAQMD to Follow the Statewide Compliance Schedule

For alternative 1, vessels throughout the State would be subject to the 15 year life compliance schedule. Vessels with homeports in the SCAQMD would not be subject to the accelerated, 13 year life, compliance schedule. The numbers of propulsion and auxiliary engines that would be replaced per year with the proposal and the two alternatives are shown in Table VIII-18. The estimated regulatory cost of this alternative, $135 million, is shown in Table VIII-19, and the new equipment cost, $463 million, is shown in Table VIII-20. The regulatory cost is about $4 million less than that for the proposed regulation due to the delayed replacement of engines in the SCAQMD. The new equipment cost is slightly higher than that for the proposed regulation due to the increased number of Tier 3 engines purchased after 2014. The total PM emissions reduced with this alternative would be about 10 percent less than with the proposed schedule, 4.4 million pounds over the 14 years from 2009 to 2022, as shown in Table VIII-21. The resulting cost-effectiveness for this alternative is slightly higher than the proposed regulation, $30 per pound of diesel PM reduced. The total NOx reduction over this same time period would be 36,000 tons. The resulting cost effectiveness, dividing the cost equally between PM and NOx, would be $15 per pound of diesel PM reduced and $1,860 per ton of NOx reduced. The cost effectiveness comparison is shown in Table VIII-22.

This alternative would slow down engine replacements in the SCAQMD. The engine replacement comparison for both alternatives is shown in Table VIII-18. This alternative does not provide the early reductions needed to help meet the South Coast Air Basin's PM2.5 attainment goals by 2014. The proposed accelerated schedule for the SCAQMD provides an additional 300,000 pounds of PM and 2,700 tons of NOx over the 2009 to 2014 time period, as shown in Table VIII-23 and in Figure VIII-5 and Figure VIII-6. This alternative is not as beneficial for air quality as the proposed regulation.

Table VIII-18: Statewide Annual In-Use Engine Replacements

Year	Number of Propulsion Engines			Number of Auxiliary Engines		
	Reg	**Alt 1**	**Alt 2**	**Reg**	**Alt 1**	**Alt 2**
2009	102	88	132	38	20	81
2010	132	115	156	111	109	106
2011	24	27	23	29	34	12
2012	48	57	25	23	24	23
2013	83	26	191	45	11	82
2014	40	22	48	29	24	53
2015	149	180	137	53	62	64
2016	23	32	138	39	58	64
2017	113	164	139	54	78	64
2018	113	72	140	54	35	65
2019	113	94	60	55	34	68
2020	113	140	49	56	65	40
2021	42	60	0	47	68	0
2022	34	49	0	28	40	0
Total	1,127	1,127	1,238	662	662	720

Table VIII-19: Statewide Annual Regulatory Costs for In-Use Repowers and New Ferry Emission Controls

Year	Regulatory Cost		
	Reg	**Alt 1**	**Alt 2**
2009	$4,452,000	$3,085,000	$6,789,000
2010	$2,634,000	$1,901,000	$3,057,000
2011	$2,551,000	$3,025,000	$2,465,000
2012	$3,142,000	$2,413,000	$3,545,000
2013	$12,175,000	$2,743,000	$31,798,000
2014	$7,543,000	$3,563,000	$9,273,000
2015	$26,277,000	$30,483,000	$26,189,000
2016	$4,319,000	$5,358,000	$24,000,000
2017	$18,103,000	$25,842,000	$21,813,000
2018	$16,711,000	$11,563,000	$19,625,000
2019	$15,319,000	$12,43,000	$10,878,000
2020	$13,926,000	$16,166,000	$8,724,000
2021	$6,679,000	$9,131,000	$1,053,000
2022	$5,672,000	$7,591,000	$1,121,000
Total	$139,504,000	$135,284,000	$170,333,000

Table VIII-20: Statewide Annual New Equipment Compliance Costs for In-Use Repowers and New Ferry Emission Controls

Year	New Equipment Compliance Costs		
	Reg	**Alt 1**	**Alt 2**
2009	$18,933,000	$16,028,000	$28,050,000
2010	$17,445,000	$13,403,000	$20,979,000
2011	$10,369,000	$12,218,000	$7,726,600
2012	$9,883,000	$10,172,000	$7,729,000
2013	$37,681,000	$10,095,000	$93,525,000
2014	$21,819,000	$9,070,000	$23,856,000
2015	$79,980,000	$94,768,000	$78,245,000
2016	$8,768,000	$11,696,000	$69,150,000
2017	$66,610,000	$97,988,000	$60,050,000
2018	$58,690,000	$43,826,000	$50,952,000
2019	$50,770,000	$43,172,000	$25,684,000
2020	$42,850,000	$52,736,000	$20,718,000
2021	$18,611,000	$26,517,000	$1,053,300
2022	$15,390,000	$21,650,000	$1,120,700
Total	$457,799,000	$463,339,000	$488,835,000

Table VIII-21: Statewide Annual PM and NOx Emission Reductions

Year	PM Reductions (pounds)			NOx Reductions (tons)		
	Reg	**Alt 1**	**Alt 2**	**Reg**	**Alt 1**	**Alt 2**
2009	59,279	46,158	94,251	525	403	849
2010	71,338	44,657	136,464	659	384	1,332
2011	110,709	98,945	139,199	1,085	963	1,385
2012	109,509	94,103	147,666	1,090	922	1,509
2013	219,218	117,951	501,494	2,127	1,179	4,780
2014	237,600	106,905	594,113	2,166	1,081	5,178
2015	506,801	446,323	658,384	4,501	4,164	5,356
2016	471,335	413,524	617,624	4,059	3,743	4,872
2017	577,086	589,948	546,537	4,672	4,928	4,067
2018	550,903	538,012	591,537	4,285	4,324	4,273
2019	514,457	489,174	588,562	3,843	3,779	4,099
2020	521,960	518,084	535,867	3,735	3,831	3,541
2021	491,391	500,452	470,245	3,393	3,594	2,913
2022	424,874	439,360	388,534	2,814	3,072	2,175
Total	4,866,459	4,443,595	6,010,479	38,955	36,367	46,326

Table VIII-22: Summary of Average Cost-Effectiveness for the Period 2009-2022

Emissions	Regulatory 2009 – 2022	Alternative 1 2009 - 2022	Alternative 2 2009 - 2022
All costs assigned to PM			
PM	$28.7 /lb	$30.4 /lb	$28.3 /lb
Divide Costs Equally Between PM and NOx			
PM	$14.3 /lb	$15.2 /lb	$14.2 /lb
NOx	$1,790 /ton	$1,860 /ton	$1,840 /ton
Combine PM and NOx Emissions			
PM + NOx	$1.7 /lb	$1.75 /lb	$1.7 /lb

All values rounded

Table VIII-23: Additional PM and NOx Emission Reductions in the SCAQMD with the Regulation Instead of Alternative 1

Year	PM Reductions (pounds)			NOx Reductions (tons)		
	Auxiliary	**Propulsion**	**Total**	**Auxiliary**	**Propulsion**	**Total**
2009	1,109	12,012	13,121	8	114	122
2010	1,560	25,121	26,681	13	262	275
2011	568	11,196	11,764	5	117	123
2012	467	14,940	15,406	4	164	168
2013	2,157	99,110	101,267	14	933	948
2014	2,753	127,943	130,696	17	1,067	1,085
Total	8,614	290,321	298,935	62	2,658	2,720

Figure VIII-5:   SCAQMD Annual PM Emissions

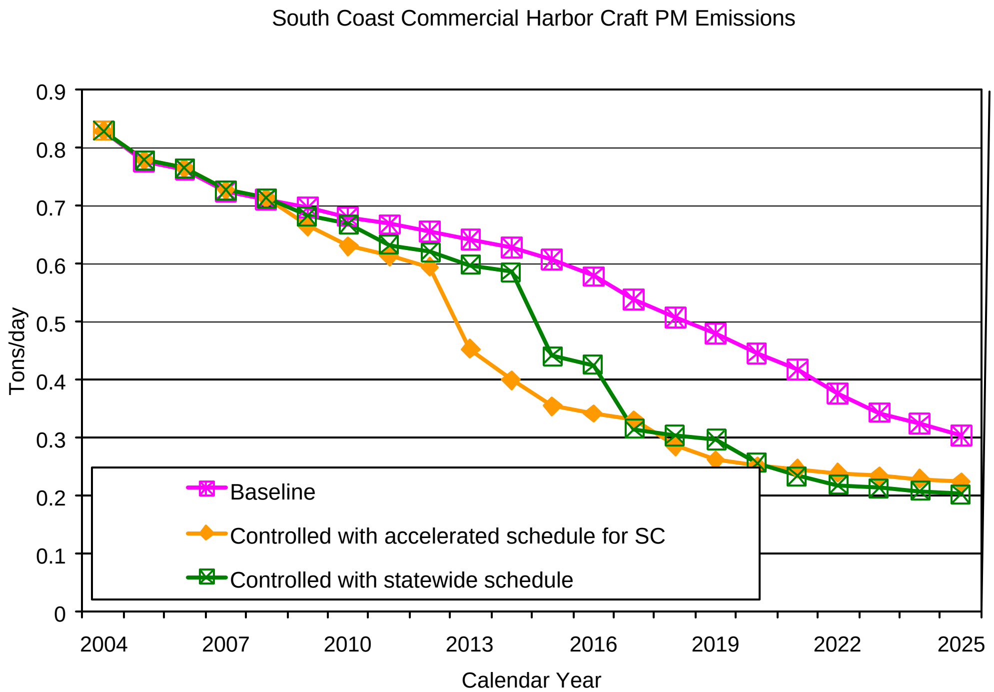
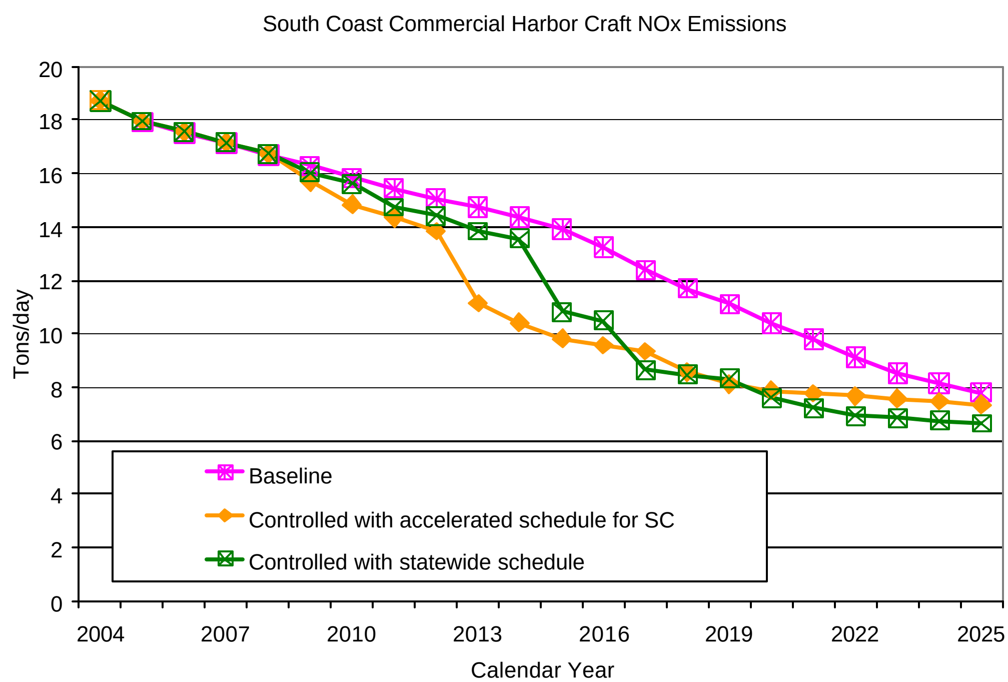


Figure VIII-6:   SCAQMD Annual NOx Emissions



Alternative 2: Accelerate the State compliance schedule to match the SCAQMD

For alternative 2, the whole state of California would be subject to the same accelerated compliance schedule as the SCAQMD which would result in many engines replaced earlier than the proposed regulation. The estimated cost of this alternative regulation to the equipment owners is greater than the proposed regulation and the cost impacts the rest of the state two years earlier. As shown in Table VIII-19 and Table VIII-20, both the estimated regulatory and new equipment compliance costs for this alternative are about $30 million higher than the costs for the proposed regulation. These costs are approximately $170 million for regulatory and $489 million for new equipment compliance costs over the 14 years from 2009 to 2022. The additional PM and NOx reductions associated with this alternative, as shown in Table VIII-21, would be about 1 million pounds PM and 7,000 tons of NOx compared to the proposed regulation. This alternative results in earlier reductions for the rest of the state, but has no additional emission benefits for the SCAQMD beyond that provided by the proposed regulation. The cost-effectiveness for this alternative is essentially the same as that with the proposed regulation at $28.3 per pound of diesel PM reduced, as shown above in Table VIII-22.

While this option achieves the emission reduction goals outlined in the Goods Movement Plan, this plan would exceed California's boat yard and maintenance facilities capabilities. This alternative, with an accelerated statewide compliance schedule, would increase the maximum number of propulsion engine repowers for a single year to about 190. The ARB staff contacted over 50 California boat yard and maintenance facilities in the State and estimate that the State repower capacity is between 217 to 271 engine repowers per year. Additional industry capacity is required for repowers due to natural engine attrition, the use of incentive funds, and regularly scheduled and emergency marine engine maintenance requirements. ARB staff believes that more than 150 repowers annually is the practical capacity limit. If the entire state were on the proposed SCAQMD compliance schedule and if all ferries, excursion vessels, tugboats, and towboats opted for the repower option, the State's capacity to do this work in would be exceeded.

The average time needed to complete a propulsion engine replacement is two to three weeks per engine. Since the ARB survey indicates that most ferries, excursion vessels, tugboats, and towboats have two propulsion engines, a typical repower may take four to six weeks or longer. These shipyards need capacity to perform engine repowers funded through incentive programs for early emission reductions and the proposed auxiliary engine replacements. This second alternative further increases the number of vessels complying early, restricting the amount of time and money from funding sources, such as the Moyer Program and Bond funding. Also, the additional early expenses for businesses reduce their ability to spread the compliance cost over the proposed time. Based on these reasons, staff does not recommend this alternative.

REFERENCES:

(ARB, 2003a) Air Resources Board, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Proposed Diesel Particulate Matter Control Measure for On-Road Heavy-Duty Residential and Commercial Solid Waste Collection Vehicles*, June, 2003.

(ARB, 2003b) Air Resources Board, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Airborne Toxic Control Measure for Stationary Compression-Ignition Engines*, September, 2003.

(ARB, 2003c) Air Resources Board, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Airborne Toxic Control Measure for In-Use Diesel-Fueled Transport Refrigeration Units (TRU) and TRU Generator Sets, and Facilities Where TRUs Operate*, October, 2003.

(EMA French) At a public workshop, on April 12, 2007 in Conference Room 230 at Cal/EPA Headquarters, Tim French, representing EMA, commented on the phone that Tier 3 marine engines are expected to cost 20% more than Tier 2 engines.