CHAPTER III

EMISSION REDUCTION STRATEGIES

A. BACKGROUND

1. Drivers for Action

Governor Schwarzenegger's Environmental Action Plan commits to reducing overall air pollution in California by 50 percent by 2010. In addition, there are four other initiatives driving the development of this plan:

- *Community Health/Environmental Justice*. Neighborhoods near ports, intermodal rail yards and high-traffic corridors suffer disproportionate air pollution impacts as compared to other locations. ARB has committed to addressing these issues through focused research, pilot programs, guidelines, regulations, targeted incentives and other efforts.

- *ARB's Diesel Risk Reduction Plan*. Diesel soot is prevalent in California air, especially around areas where diesel sources like those used for goods movement are concentrated. Diesel PM accounts for more than 70 percent of the known cancer risk from air toxics in the State. In 2000, ARB adopted a comprehensive *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-fueled Engines and Vehicles,* establishing a goal of 85 percent reduction in risk from diesel PM by 2020.

- *California's State Implementation Plan*. The national ambient air quality standards for ozone and fine particles are important benchmarks for public health. Federal law requires California to develop a State Implementation Plan (SIP) for each region that violates national standards that identifies sufficient emission reduction measures to attain the standard(s) by the applicable deadline(s). California is preparing SIPs for 15 ozone areas and two fine particulate (PM2.5) areas, due in 2007-2008. Emissions from goods movement must be significantly reduced by 2015 to fulfill these requirements.

- *Business, Transportation & Housing Agency (BT&H) - California Environmental Protection Agency (Cal/EPA) Goods Movement Action Plan*. ARB's emission reduction plan is also an important part of the State's overall initiative to accommodate the anticipated growth in international goods movement while mitigating the existing and future impacts on California's environment and communities.

2. Scope of Plan

Emission Sources. This plan quantifies the emissions from five sectors associated with ports or the distribution of international cargo throughout California:

- All ships (cargo and passenger vessels) operating in California ports and up to 24[1] nautical miles from the California coast.
- All commercial harbor craft (tugs, ferries, and fishing vessels).
- Cargo handling equipment used to move imported and exported goods at ports and intermodal rail yards.
- Trucks moving imported and exported goods throughout California.
- Trains moving imported and exported goods throughout California.

The plan highlights the emissions impacts of cargo-handling equipment, trucks and trains moving international goods in the State. However, the same emission reduction strategies will apply to sources moving domestic cargo in rail yards, distribution centers, and along high-traffic corridors. For each sector, the plan describes the kinds of equipment and engines used, highlights actions taken since 2001 to reduce emissions, then identifies additional emission reduction strategies needed to protect public health.

Pollutants. The strategies are designed to reduce the highest priority pollutants – diesel particulate matter (diesel PM) and nitrogen oxides (NOx) – that are responsible for most of the mortality and health risk associated with goods movement. The plan also seeks to reduce two additional pollutants where possible – reactive organic gases (ROG) and sulfur oxides (SOx) – since both contribute to ambient particle formation, although at a lesser degree, and because ROG is key ingredient of ozone.

Timeframe. Further emission reductions from all sectors are needed to reduce existing health impacts in communities as quickly as possible and to meet air quality standards by federal deadlines. ARB staff used the 2001 calendar year as the starting benchmark because it is the first year for which there is extensive data on port-related emissions. It is also close to the 2000 starting point in ARB's Diesel Risk Reduction Plan and the 2002 base year required for the new State Implementation Plans. The Port of Los Angeles' No Net Increase effort used 2001 as the base year as well. 2005 emissions for each sector are provided to illustrate current levels. Future baseline emissions with "on-the-books" controls are projected for 2010, 2015, 2020, and 2025, with corresponding emission goals for each milestone through 2020.

[1] We have used 24 nautical miles because this distance is consistent with the current regulatory proposal for fuel used in ship auxiliary engines. In development of the new State Implementation Plans, we will consider the appropriate range for that purpose.

3. Emission Reduction Goals

The statewide emissions from ports and international goods movement in California are over 500 tons per day. Table III-1 shows the emissions of each pollutant over time, with the benefits of air pollution controls already adopted by ARB, local air districts, U.S. EPA, and other agencies.

Table III-1
Statewide Emissions from All Ships and Harbor Craft, Plus Cargo-Handling Equipment, Trucks*, and Locomotives that are Used to Move Imports and Exports with Benefits of All Measures Adopted as of October 2005
(tons per day)

Pollutant	Year					
	2001	2005	2010	2015	2020	2025
Diesel PM	17.6	19.2	20.0	22.7	27.5	35.2
NOx	406.3	394.6	373.2	379.3	406.1	468.0
ROG	32.0	29.3	26.9	26.8	27.7	21.1
SOx	63.3	78.6	96.8	122.1	158.7	212.9

The extensive suite of measures already in place are ensuring that trucks, cargo handling equipment, harbor craft, and locomotives will continue to get cleaner into the future. But the very minimal controls on ships, and the anticipated increase in international cargo, will reverse our emission reduction progress without significant new strategies. To meet our health goals, we must do much more, much faster.

The statewide goals for this emission reduction plan are:

- **2010**: Reduce projected 2010 statewide emissions of diesel PM, NOx, SOx, and ROG from port-related sources and the import and export of cargo to 2001 levels or below to mitigate the impacts of growth.

- **2020**: Reduce the health risk from diesel PM from port-related sources and the import and export of cargo to 85 percent below 2000 levels to achieve the Board's diesel risk reduction goal.

The South Coast specific goals of the plan are:

- **2015**: Reduce projected 2015 emissions of NOx from port-related sources and the import and export of cargo in the South Coast by 30 percent to aid attainment of the federal PM2.5 standards.

- **2020**: Reduce projected 2020 emissions of NOx from port-related sources and the import and export of cargo in the South Coast by 50 percent to aid attainment of the federal 8-hour ozone standard.

Goals for other areas will be determined through the State Implementation Plan process.

4. Implementation Mechanisms

Successfully mitigating the air quality impacts from goods movement activities will require aggressive action to reduce emissions from all sources regulated by state, local, national and international agencies. Certain strategies, such as emission standards for new engines, are best applied as a regulation. Other strategies such as the early replacement of older diesel trucks operations with cleaner models will require a mix of regulatory and incentive approaches. Where California authority is questionable and international emission standards are not aggressive enough to meet our needs, voluntary agreements with enforcement provisions may be the fastest way to secure rapid emission reductions. The complexity of the goods movement arena and its multi-jurisdictional nature necessitate a full spectrum of approaches. The implementation mechanisms that California could pursue include:

- California Rules and Regulations. ARB and local agencies throughout the State can adopt regulations that compel the use of clean technologies by setting new emission standards or by requiring the use of cleaner technologies. These regulatory approaches are most effective where there is clear legal authority vested in the State or local agency.

- National and International Actions. National regulations, other actions, and funding programs can fulfill the federal government's responsibility to clean up air pollution sources under its jurisdiction. Also, the federal government's advocacy is essential to secure further international actions on emission standards for ships through the International Maritime Organization.

- Incentives. Incentive programs encourage owners and operators of port equipment to voluntarily reduce their emissions and to accelerate the reduction of port-related emissions. There are two types of incentive programs – those that provide funding to purchase cleaner equipment (like California's Carl Moyer Program), and those that use incentives such as reduced port fees to reward lower-emitting or more efficient operations.

- Market Participation Concepts. Market forces can also influence the actions that private companies take to reduce emissions. These concepts could include ports using their lease agreements to negotiate greater utilization of low-emission technology, and/or mitigation fees to achieve comparable reductions from other sources affecting the nearby community.

- Enforceable Agreements. Properly executed enforceable agreements can be effective in reducing emissions in the absence of clear regulatory authority and without the lag time associated with litigation. On July 21, 2005, the Board adopted procedures to be used when entering into or amending future agreements with the

owners of air pollution sources. Under these procedures, ARB's Executive Officer will notify the Board and the public, and solicit public comment on the subject of the proposed agreement prior to starting negotiations. The Executive Officer can then negotiate an agreement with the source, but the resulting agreement must be approved by the Board before it can take effect. The Board's Ombudsman will inform the Board of the public's involvement when the Board considers ratification.

- Robust Environmental Review and Mitigation. The California Environmental Quality Act (CEQA) includes a comprehensive check list for evaluating environmental impacts and determining the need for mitigation. However, there is also provision for a finding of "overriding considerations," whereby certain impacts and/or mitigation options may be set aside. Applying greater rigor to the CEQA review could prevent excess emissions from occurring during construction and operation of the project. Alternatively, a consolidated CEQA process might do a better job of capturing the aggregate impacts and benefits of modifications to the goods movement system, enabling more effective mitigation measures to be identified and impelmented

- Lease Agreements. Port authorities may stipulate environmental conditions as part of their negotiations over new and expanding leases. This mechanism has been successfully used to create the greenest terminal on the West Coast and should be continued in the future.

B. SHIPS

1. Introduction

Ocean-going vessels, or "ships," bring the vast majority of imported goods into California. "Ships" include international vessels such as container ships, bulk carriers, general cargo ships, tankers, and the "roll-on, roll-off" ships used to transport automobiles. Passenger cruise ships are not part of the goods movement sector, but are included in our analyses because their emissions impact communities near ports. Military vessels are not addressed in this report. The smaller vessels that tend to operate primarily in California's coastal waters (such as ferries, tugboats, and commercial fishing vessels) are addressed in the "commercial harbor craft" category.

Most ships are propelled by large diesel piston engines, although some are powered by steam turbines or diesel-fueled turbines. Most propulsion engines are mechanically connected to the ship's propeller. The propulsion diesel piston engines powering the majority of oceangoing ships are referred to by U.S. EPA as "category 3" engines.

Some ships use their diesel engines to drive generators that produce electricity for an electric propulsion motor; this configuration is commonly used in passenger cruise ships.

In addition to the propulsion engines, ocean-going ships generally run auxiliary diesel generators and boilers. Diesel generators provide electrical power for lights and equipment, and boilers provide steam for hot water and fuel heating. Most vessels turn off their propulsion engines while at dockside ("hotelling") and only operate their auxiliary engines and boilers, which are significant emission sources at ports.

Although the power systems described above are characterized as "diesel-fueled," the types of fuel vary. Most ocean-going ships run their main propulsion engines and auxiliary engines on heavy fuel oil (or "bunker fuel"), which typically costs between 30 to 50 percent less that refined diesel oil. This fuel is very viscous and requires heating to allow it to be pumped and injected into an engine. Bunker fuel typically contains much higher levels of sulfur, nitrogen, ash, and other compounds which increase exhaust emissions. For example, typical bunker fuel used by ships visiting California ports averages about 25,000 parts per million (ppm) sulfur, compared to about 120 ppm sulfur for California on-road diesel today and 15 ppm sulfur for California diesel beginning statewide in 2006. Some propulsion and auxiliary engines use lighter "distillate" diesel fuel (also referred to as marine gas oil or marine diesel oil). These fuels have much lower levels of sulfur and other contaminants compared to bunker fuel, but higher sulfur levels than land-based diesel fuels.

The factors that determine the level of emissions from ships are ship engine standards and age, the fuel used, and operational practices such as vessel speed, how auxiliary engines are used while in port, and the amount of time spent in and near ports. Ocean-going ships emit more of almost every pollutant addressed in this plan than any other goods movement sector, primarily because the engines and fuels used in these ships have been relatively uncontrolled.

Ship emissions can be reduced with many of the same technologies and fuels that are reducing land-side emissions. Staff also expects that that ship engines will at some point be as clean as those used in stationary diesel engines and off-road equipment, when compared in terms of energy output. There are significant logistical, infrastructure, and legal considerations that will affect how quickly these technologies can be adapted or required for use on ships. However, there is also an international concern about the impact ships have on the environment, particularly in portside cities, and a growing international demand for less polluting ships.

Ships are currently subject to very few emission limits. The international nature of the shipping industry presents a major hurdle, as illustrated by the fact only 13 percent of the approximately 1,900 ships that visited California ports in 2004 were U.S.-flagged vessels. Ships are subject to even fewer fuel quality restrictions. In theory, individual ports can impose operational restrictions to reduce emissions. However, there are advantages to a consistent approach on a statewide level, or beyond.

Within the last several years, action has been taken at both the international and national level to begin to address the emissions from commercial marine vessels. As explained below, these regulations are expected to achieve relatively modest emission

reductions in California. Other programs established within California are also described below.

The International Maritime Organization (IMO) established NOx standards in 1997. The standards apply to all new diesel engines used on ocean-going vessels. Engine manufacturers have generally produced compliant engines since 2000. However, the rule is expected to result in only modest reductions in NOx emissions, and no reductions in other pollutants. In 1999, U.S. EPA set national emission standards for new "category 1 & 2" engines, which would apply to most auxiliary engines. This rule will reduce NOx, ROG, and diesel PM emissions. However, this rule applies to new engines in U.S.-flagged vessels, which make up about 13 percent of the vessels that visit California ports.

2. Actions Taken Since 2001

- ✓ Vessel Speed Reduction Agreement. In May 2001, a voluntary speed reduction program was initiated at the Ports of Los Angeles and Long Beach. The agreement calls for ocean-going vessels entering or leaving the ports to slow to 12 knots within 20 nautical miles of the ports. The speed reduction reduces fuel use and lowers NOx emissions.

- ✓ U.S. EPA Main Engine Emission Standards. In 2003, U.S. EPA set NOx standards for new "category 3" engines used for propulsion of ocean-going vessels. The standards are identical to the International Maritime Organization NOx standards and thus achieve little NOx emission reductions and no diesel PM reductions. In addition, the rule applies only to new engines on U.S.-flagged vessels, which represent a small proportion of the vessels visiting California ports.

- ✓ U.S. EPA Nonroad Diesel Fuel Requirements. In 2004, U.S. EPA acted to limit the sulfur content of diesel fuels for non-road applications. For marine use, the rule would limit the fuel sulfur content to 500 ppm in 2007 and 15 ppm in 2012. The rule does not apply to marine diesel oil or heavy fuel oil. Since most ocean-going vessel auxiliary engines use heavy fuel oil, the federal rule will have little impact in reducing emissions from this source.

Table III-2 shows that existing international and U.S. EPA regulations are slightly reducing emissions from individual ships, but are far outpaced by emission increases due to anticipated growth in both cargo-related ships and cruise ships.

Table III-2
Statewide Emissions from All Ships* Within 24 Miles of California Coast with Benefits of All Measures Adopted as of October 2005
(tons per day)

Pollutant	Year					
	2001	2005	2010	2015	2020	2025
Diesel PM	7.8	10.0	12.6	15.9	20.7	28.0
NOx	94.2	116.9	143.3	177.3	222.7	297.8
ROG	2.5	3.1	3.7	4.6	6.1	8.1
SOx	58.6	75.4	95.5	121.1	157.6	212.8

* Includes emissions from all types of cargo ships, plus passenger cruise ships.

3. Strategies to Further Reduce Emissions

The marine industry is diverse and has only recently been subject to air quality regulation. Information regarding duty cycles, emission factors, and the effectiveness of controls on marine engines is less definitive than for other mobile sources. Many of the measures proposed in this document will require the cooperation and collaboration of multiple agencies on the local, State, national, and international level. These efforts may include the formation of an international coalition of environmental agencies, shipping companies, engine manufacturers, and/or port authorities.

To provide a central point in California for the coordination and discussion of air quality strategies for the maritime community, the ARB established the Maritime Air Quality Technical Working Group (Maritime Working Group) in 2001. The group is open to all interested parties and includes representatives from California ports, commercial shipping companies, U.S. EPA, local air quality districts, maritime industry associations and community and environmental groups.

The Maritime Working Group has facilitated emission reduction measure development by providing a forum for discussion of strategies at the early, conceptual stage. Engine manufacturers and emission control technology suppliers have presented information to help the process as well. The Maritime Working Group has also facilitated emissions testing projects, and is currently assisting in the demonstration of retrofit emission control technologies on a large container ship. We envision the Maritime Working Group to be the forum for continuing cooperation and collaboration as we work to achieve emission reductions from this category over the next several years.

The strategies discussed below are based on potential emission reduction approaches that can be categorized broadly as: (1) cleaner engines; (2) cleaner fuels; (3) exhaust control devices/capture of emissions; and (4) operational controls, such as speed reduction zones. The strategies are organized by estimated date of implementation. However, there is significant overlap since many of these strategies will develop over many years, and will be phased in. In addition, due to complex jurisdictional issues and the international nature of ships, alternative implementation mechanisms may be needed in addition to traditional regulations. These mechanisms may include voluntary,

enforceable agreements, market-based approaches, emission reduction credit programs, and incentive programs.

Vision for Cleaner Ships. Regardless of the mechanisms used to obtain emission reductions, the technology exists to significantly reduce ship emissions. Accordingly, the plan envisions the steady phase-in of much cleaner vessels between now and 2020. In terms of an individual vessel, several of the approaches discussed below could be combined to produce cleaner ships (either newly built or retrofitted) with dramatically lower emissions of diesel PM, NOx, and SOx. For example, newly built vessels, and in many cases retrofitted vessels, could incorporate the following technologies:

- Install fuel tanks, piping, and other modifications, if necessary, to allow the main and auxiliary engines to operate on marine distillate. The use of these fuels could reduce emissions of diesel PM and SOx by about 75 percent or greater, and reduce emissions of NOx by about 6 percent, compared to the standard heavy fuel oil now used by most vessels.

- Incorporate catalytic exhaust controls such as selective catalytic reduction on the main (new vessels only) and auxiliary engines. The use of this technology could control NOx emissions by 90 percent or greater.

- Install tanks, piping, and other modifications, if necessary, to allow the main engines to operate on reduced sulfur fuels (i.e. 5,000 ppm sulfur). The use of this fuel would reduce diesel PM emissions by about 35 percent and SOx emissions by about 80 percent. PM emissions could also be reduced by installing more advanced “slide-valve” fuel injectors.

- Modify dockside facilities, and retrofit or build the vessels with the capability to utilize shore-side power at dock. The use of shore-side power would reduce emissions of diesel PM, NOx, and SOx from auxiliary engines by over 95 percent each during hotelling.

- Install equipment necessary for the main engine to use emulsified fuels. The use of emulsified fuels can reduce NOx emissions by 30 percent or more. Further reduce NOx from the main engine through increased compliance with speed reduction zones.

Implementation of the overall strategy will require a combination of regulatory efforts, incentive or market based programs, and cooperative agreements. Some fuel related measures can be accomplished by actions by the ARB or U.S. EPA. Engines standards by IMO could become an important component. Increased use of shore power could be done via regulation, or by other means such as port leases. Measures that involve modifying or building ships to exceed IMO emission standards and the preferential deployment of those vessels to California services will likely require some combination of incentive, market-based, regulatory and cooperative agreement approaches.

The strategies described below envision that all of these implementation options will be considered for this sector. The goal is to produce a viable approach that results in a steadily increasing supply of lower-emitting vessels with clean engines and/or shore power capability, and ensures a rapid increase in the use of these vessels in California service. Emission reduction goals begin in 2010, with increasingly aggressive targets by 2015 and as full as possible implementation by 2020.

a. Implementation Possible by 2010

Emission reductions from the following measures could reduce ship PM and NOx emissions significantly by 2010.

i. ARB Rule for Ship Auxiliary Engine Fuel

In December 2005, ARB will consider a proposed regulation to require auxiliary engines on ocean-going vessels to significantly reduce diesel PM, NOx, and SOx emissions. The proposed regulation would apply while vessels are within 24 nautical miles of the California coastline. Compliance could be achieved by using cleaner-burning marine distillate fuels, or implementing equally effective strategies under an Alternative Compliance Plan. For vessels complying with the fuel requirement, operators will need to use marine gas oil, or marine diesel oil meeting a 5,000 ppm sulfur limit, instead of the bunker fuel typically used by vessels. If operators choose an Alternative Compliance Plan, they must demonstrate that the alternative strategies will result in no greater emissions than what would have occurred by complying with the fuel requirements. The proposed regulation will apply to both U.S.-flagged and foreign-flagged vessels.

ii. Cleaner Marine Fuels

Operate main engines on lower sulfur heavy fuel oil or marine distillate fuels. Currently most vessels operate their main engines on heavy fuel oil, which contains high levels of sulfur, ash, and nitrogen compounds. Compared to typical heavy fuel oil, marine distillate fuels will reduce emissions of diesel PM and SOx by about 75 percent, and emissions of NOx by about 6 percent. Use of lower sulfur heavy fuel oil (5,000 ppm sulfur) would result in about an 80 percent SOx reduction, and about a 35 percent PM reduction. The disadvantage of using these cleaner burning fuels is higher cost. For example, distillate marine fuels typically cost 50 to 100 percent more than heavy fuel oil. In addition, there are various technical issues that must be resolved with operating some main engines on distillate fuels.

iii. Emulsified Fuels

Operate main and auxiliary engines on emulsified fuels. This technology has already been demonstrated on marine engines and marine-type engines used in land-based power-plant applications. On-board systems that can produce emulsified fuels by mixing heavy fuel oil and water under high pressure can be installed on vessels.

Emulsified fuels reduce emissions of NOx by reducing peak temperatures within the combustion chamber, which reduces the formation of NOx. These systems generally reduce NOx emissions in proportion to the amount of water in the emulsified fuel. We expect that a 30 percent or greater reduction in NOx is possible. Drawbacks include the need to store large quantities of fresh water (saltwater cannot be used), and slight increases in fuel consumption and PM emissions that are possible at high levels of water.

iv. Expanded Vessel Speed Reduction Programs

Investigate the feasibility and benefits of expanding the existing vessel speed reduction program at the Ports of Los Angeles and Long Beach by increasing the distance offshore, or by extending the program to other ports. Vessel speed reduction zones reduce main engine fuel consumption and result in significant NOx reductions. However, compliance with the existing program has been below 50 percent for some time periods, so options for increasing voluntary compliance, or a mandatory program, may be necessary. Another potential drawback is concern with the increased time it takes a vessel to reach its destination, which could impact ship schedules if the area covered by the program is increased.

v. Install Engines in New Vessels that Exceed IMO Standards

International shipping is growing, and new vessels are being introduced into service at a fairly rapid pace. Newer vessels with cleaner engines could begin to be placed into California service by 2010. Some technologies, such as fuel emulsion systems, slide valves, lower emission auxiliary engines and the capability to use shore power could be incorporated into vessels now under construction. Other technologies such as main engine SCR systems could be designed and deployed into a limited number of vessels put into service by 2010. Because of the long lead times in vessel design and construction, the impact of these strategies would be limited in 2010.

vi. Dedicate the Cleanest Vessels to California Service

Accelerate the use of vessels with cleaner new or retrofitted engines at California ports. This could be accomplished by assigning the cleanest vessels to routes that frequently visit California ports. Possible reductions by 2010 are expected to be modest, because of the limited availability of cleaner vessels by that date. It is difficult to predict how quickly cleaner ships will become available and can be deployed to California ports in the 2010 timeframe. For the purpose of this plan, it is assumed that 20 percent of the ship calls at California ports by 2010 will be made by vessels with new or retrofitted engines that achieve 30 percent lower NOx and PM than current IMO standards. This could be accomplished if 100 ships (5 percent of the total ships) that visit California most frequently are equipped with these engines.

vii. Shore Based Electrical Power

Use shore-side electrical power (called cold ironing) to allow vessel operators to turn off their diesel powered auxiliary engines. Use of shore-side power dramatically reduces vessel hotelling emissions, and could be partially implemented by 2010. The disadvantage of cold ironing is the high cost of dockside infrastructure and vessel retrofits, as well as the high cost of electricity relative to shipboard generation from diesel engines. For the purpose of this plan, it is assumed that 20 percent of the ship calls at California ports by 2010 will be made by vessels that use shore power, and 20 percent of the other vessels utilize alternative at-dock reduction technologies.

This process is currently being used by several West Coast ports. For example, the Princess Cruise vessels that dock in Juneau, Alaska and Seattle, Washington use shore-side power for hotelling. USS-POSCO industries has four vessels that have been cold ironing at a Pittsburg, California terminal since the early 1990s. The Port of Los Angeles retrofitted the China Shipping terminal to include shoreline power infrastructure. Two China Shipping vessels began connecting to shore power in June 2004, with the goal of 70 percent of the vessels visiting the terminal using shore power. Also at the Port of Los Angeles, shore-side infrastructure is currently being constructed to allow an NYK Atlas container vessel already built with cold ironing capabilities to use shore-side power. The Port of Long Beach will also provide cold ironing capabilities for two British Petroleum tankers that regularly visit the port.

Shore power is unlikely to be a cost-effective strategy for those ships that visit California ports infrequently. Alternative technologies such as barge-mounted control systems maybe a sensible alternative for many of these vessels, and such systems could begin to be deployed by 2010.

b. Implementation Possible by 2015

The following strategies, in addition to continued progress on the previous measures, will further reduce emissions by the 2015 timeframe.

i. Extensive Retrofit of Existing Engines

Install cleaner technology on existing vessels during major engine maintenance operations. For example, retrofit existing fuel injectors with slide-valve designs, or install technology to reduce engine oil consumption. Programs to install such technology could provide substantial emission reductions by 2015 if engine manufacturers continue to expand the selection of retrofit devices. Currently such technologies are relatively limited, and only available on certain models. However, increased interest and advances in technology may result in an increasing array of low emission retrofits. The disadvantage will be higher cost compared to standard replacement parts.

ii. Highly Effective Emission Controls on Main Engines and Auxiliary Engines

Install emission control devices on new or existing engines that frequently visit California ports. For example, exhaust emission controls such as selective catalytic reduction are available now and can be installed on new vessels, or in some cases retrofitted on existing auxiliary engines. This technology can reduce NOx and ROG emissions by 90 percent or greater, and in some cases may reduce diesel PM emissions as well. We expect that additional emission control systems will be available for marine applications in 2015. The disadvantage of such systems is high initial (capital) cost, and ongoing higher costs for operation and maintenance. For example, in the case of selective catalytic reduction, ammonia or urea is injected into the catalyst during operation which requires ongoing costs. Selective catalytic reduction and other control devices can also displace space on a vessel and reduce its cargo capacity.

iii. Sulfur Emission Control Area (SECA)

ARB is working with U.S. EPA to establish a SECA off California's coast (or beyond) under the provisions of the International Maritime Organization, MARPOL Annex 6. A SECA designation would limit the sulfur content of marine heavy fuel oil to no more than 15,000 ppm, well below the current average of about 25,000 ppm. Currently, U.S. EPA is in the process of evaluating the feasibility of a North America SECA that would include the California coastline. By 2015, a SECA requirement limiting the sulfur content of fuel to 5,000 ppm would reduce PM emissions by about 35 percent, and SOx emissions by about 80 percent.

iv. Expanded Use of Cleanest Vessels in California Service

Greatly increase the use of vessels with cleaner new or retrofitted engines at California ports. This could be accomplished by assigning the cleanest vessels to routes that frequently visit California ports. Possible reductions by 2015 are expected to be very significant assuming that cleaner vessels have become widely available by that date. For the purpose of this plan, it is assumed that 25 percent of the visits could be by new ships that achieve 90 percent PM and 60 percent PM reductions. It is further assumed that another 50 percent of the ship calls at California ports by 2015 could be made by vessels with new or retrofitted engines that achieve 30 percent lower NOx and PM than current IMO standards. This could be accomplished if 200 ships that visit California most frequently, (approximately 10 percent of all ships that visit California's ports) were new vessels built with the best available controls (90% NOx/60%PM) and 400 additional vessels were equipped with engines that achieve 30% NOx and PM reductions.

v. Expanded Shore Power and Alternative Controls

Expand the existing use of shore-side electrical power or other dockside controls to allow vessel operators to turn off their diesel powered auxiliary engines. Use of shore-side power dramatically reduces vessel hotelling emissions, and could be widely

deployed and result in very substantial reductions by 2015. For the purpose of this plan, it is assumed that 60 percent of the ship calls at California ports by 2015 will be made by vessels that use shore power, and 20 percent of the other vessels utilize alternative at dock reduction technologies. This would require approximately 500 vessels (25 percent of the total) to be capable of using shore power, or deploy equivalent on-board controls.

c. Implementation Possible by 2020

As cleaner ship technologies become available, additional emission reductions can be achieved by continuing to direct those vessels to California.

i. Full Use of the Cleanest Vessels in California Service

Maximize the use of vessels with cleaner new or retrofitted engines at California ports. This could be accomplished by assigning the cleanest vessels to routes that frequently visit California ports. For the purpose of this plan, it is assumed that 50 percent of the visits could be by new ships that achieve 90 percent PM and 60 percent PM reductions. It is further assumed that another 40 percent of the ship calls at California ports by 2015 could be made by vessels with new or retrofitted engines that achieve 30 percent lower NOx and PM than current IMO standards. This could be accomplished if 400 ships (20 percent) that visit California most frequently were new vessels built with the best available controls (90% NOx/60%PM) and 800 additional vessels were equipped with engines that achieve 30% NOx and PM reductions. This measure recognizes that another approximately 800 vessels that have not been equipped with any additional emission controls and call in California infrequently will continue to use California ports.

ii. Maximum Use of Shore Power or Alternative Controls

Achieve the full potential of the use of shore-side electrical power or other dockside controls to allow vessel operators to turn off their diesel powered auxiliary engines. The use of shore-side power dramatically reduces vessel hotelling emissions, and could be fully deployed by 2020. For the purpose of this plan, it is assumed that 80 percent of the ship calls at California ports by 2020 will be made by vessels that use shore power, and half of the remaining vessel calls would be vessels that could use utilize alternative at dock reduction technologies. This would require approximately 600 vessels (30 percent of the total) to be capable of using shore power, or deploy equivalent on-board controls.

4. Emission Reduction Benefits

Table III-3 shows the benefits of the strategies described in this section for ships.

Table III-3
Statewide Emissions from All Ships Within 24 Miles of California Coast with Benefits of Plan
(tons per day)

Pollutant	Year				
	2001	2005	2010	2015	2020
Diesel PM					
Emissions with Existing Program	7.8	10.0	12.6	15.9	20.7
New Reductions - ARB Auxiliary Engine Fuel Rule	--	--	-3.2	-4.0	-5.2
New Reductions – 2010 Strategy	--	--	-0.7	-6.9	-9.4
New Reductions – 2015 Strategy	--	--	--		
New Reductions - 2020 Strategy	--	--	--	--	
New Reductions - Total	--	--	-3.9	-10.9	-14.6
Emissions with Plan	7.8	10.0	8.7	5.0	6.1
NOx					
Emissions with Existing Program	94.2	116.9	143.3	177.3	222.7
New Reductions - ARB Auxiliary Engine Fuel Rule	--	--	-2.5	-3.2	-4.1
New Reductions - 2010 Strategy	--	--	-17.2	-84.2	-140.8
New Reductions - 2015 Strategy	--	--	--		
New Reductions - 2020 Strategy	--	--	--	--	
New Reductions - Total	--	--	-19.7	-87.4	-144.9
Emissions with Plan	94.4	116.9	123.6	89.9	77.8
ROG					
Emissions with Existing Program	2.5	3.1	3.7	4.6	6.1
New Reductions - ARB Auxiliary Engine Fuel Rule	--	--	--	--	--
New Reductions - 2010 Strategy	--	--	--	--	--
New Reductions - 2015 Strategy	--	--	--		
New Reductions - 2020 Strategy	--	--	--	--	
New Reductions - Total	--	--	--	--	--
Emissions with Plan	2.5	3.1	3.7	4.6	6.1
SOx					
Emissions with Existing Program	58.6	75.4	95.5	121.1	157.6
New Reductions - ARB Auxiliary Engine Fuel Rule	--	--	-27.6	-35.0	-45.7
New Reductions - 2010 Strategy	--	--	-26.9	-71.2	-96.0
New Reductions - 2015 Strategy	--	--	--		
New Reductions - 2020 Strategy	--	--	--	--	
New Reductions - Total	--	--	-54.5	-106.2	-141.7
Emissions with Plan	58.6	75.4	41.0	14.9	15.9

C. COMMERCIAL HARBOR CRAFT

1. Introduction

Harbor craft operate primarily along California's coastline and inland waterways. These vessels generally stay within California coastal waters and usually leave and return to the same port. The commercial vessels related to goods movement include tug/tow boats, pilot boats, work boats, crew/supply boats, and others. These vessels, as well as other harbor craft such as ferries and fishing vessels, operate in and around ports and their emissions contribute to community health risk. We have included all types of harbor craft, not just those used in goods movement, in our analyses in this plan.

Most harbor craft use diesel-powered propulsion and auxiliary engines. In 2002, there were approximately 4,100 commercial harbor craft, with 7,400 engines, operating in California's waters. Of that number, approximately 250 were tugboats, towboats and work boats – boats that serve import goods movement – with 700 engines.

U.S. EPA established new engine standards for new "category 1 & 2" engines – engines with a displacement less than 30 liters per cylinder that are used for propulsion in most harbor craft. This rule specifies standards for NOx plus hydrocarbons, particulate matter, and carbon monoxide. The standards are effective from beginning in 2004, 2005, or 2007, depending on the engine size. The emission reductions from the federal rule are expected to be modest. The NOx standards will not achieve significant emission reductions until after 2010, since the standards only apply to new engines introduced beginning 2004-2007. In addition, the PM and carbon monoxide standards are effectively caps in many cases, designed primarily to prevent increases.

2. Actions Taken Since 2001

Several key actions have been taken since 2001 to reduce emissions from harbor craft:

- ✓ Incentives for Cleaner Engines. Since 1998 the Carl Moyer Program has been offering monetary incentives to reduce NOx emissions from diesel engines below the levels required by current standards, agreements, and regulations. The most common action has been to replace an older diesel engine with a cleaner diesel, resulting in up to a 60 percent decrease in NOx and PM emissions. ARB and local air districts have provided over $17 million to replace more than 300 older, dirty diesel engines in harbor craft with new, cleaner engines, resulting in emission reductions of 2.5 tons per day of NOx and 0.1 tons per day of diesel PM.

- ✓ Low Sulfur Diesel Fuel Rule. In 2004, ARB adopted a regulation that requires harbor craft to use cleaner diesel fuel in the South Coast beginning in January 2006, and statewide starting January 2007. Diesel fuel sold or supplied to most commercial (and recreational) harbor craft must meet the same fuel specifications as the diesel used in on-road trucks. This fuel has a low sulfur content (15 ppm) and lower aromatic hydrocarbons. For vessels not already using California's on-road

diesel fuel, NOx reductions of five percent and PM reductions of nine percent are expected. More importantly, the fuel enables these vessels to apply high efficiency emission control devices (such as diesel particulate filters) that will reduce diesel PM by 85 percent or more.

3. Strategies to Further Reduce Emissions

As shown in Table III-4 adopted ARB and U.S. EPA regulations, plus other programs, are reducing emissions from individual harbor craft.

Table III-4
Statewide Emissions from All Harbor Craft*
with Benefits of All Measures Adopted as of October 2005
(tons per day)

Pollutant	Year					
	2001	2005	2010	2015	2020	2025
Diesel PM	4.2	4.3	4.0	3.9	3.9	3.9
NOx	85.8	86.1	83.9	82.7	82.7	82.7
ROG	8.7	8.7	8.7	8.6	8.6	8.6
SOx	0.5	0.5	0.2	0.1	0.1	0.1

* Includes emissions from tugs, ferries, and commercial fishing boats.

Below we outline additional strategies that could reduce emissions from harbor craft.

a. Implementation Possible by 2010

i. ARB Rule to Clean Up Existing Engines

ARB is in the process of developing a regulation to reduce emissions from the main propulsion and auxiliary engines used in commercial harbor craft. The goal is to reduce emissions by re-powering existing harbor craft with cleaner engines, by using cleaner alternative fuels, or by applying add-on emission control technologies.

Due to the diversity within the harbor craft category, specific emission reduction proposals will vary with the type of vessel, industry, and other factors. For example, tugs and ferries tend to operate primarily near ports and neighboring communities and have high annual hours of operation. The engines on these vessels are also typically newer and the vessels are larger. These factors provide more opportunity for the application of retrofit devices or the repowering of vessels with newer cleaner engines.

Fishing vessels, however, tend to be a much older and operate several miles off the coastline for a large percentage of the time. The fishing industry is also facing difficult economic times due in part to increased competition with the globalization of the industry, and other factors such as restrictions on fishing off the California coast. These issues will need to be considered as control measures are developed to ensure the final proposal will not have an adverse economic impact on California businesses.

Cleaner Engines. The diesel engines typically used in harbor craft were built for durability, with little or no consideration for emissions control. U.S. EPA has adopted harbor craft engine standards that apply to new vessels beginning in 2004. On some vessels, older dirty engines can be replaced or repowered with newer, cleaner engines. Ease of engine replacement varies widely vessel to vessel. For example, many fishing vessels are older, use two-stroke engines, and have limited space. A cleaner new four-stroke model is physically larger and may not fit into the engine compartment without major hull, vessel, and electrical modifications.

Nevertheless, there are many examples of vessels being repowered with cleaner engines. For example, the engines in many tugboats working in Los Angeles harbor have been successfully repowered with newer, cleaner engines since 2001 under the South Coast Air Quality Management District Rule 1631 to generate credits for use by industrial sources. This program also demonstrated that equivalent emission reductions can be achieved from remanufactured engines. Remanufacturing marine engines is the process where all engine components, except for the existing engine block, are replaced with new original equipment manufacturer parts. Some engines have newer fuel injectors, aftercoolers, turbochargers and other parts added to the original engine setup to lower the engine emissions. The Port of Oakland and the Carl Moyer Program have also subsidized a number of cleaner engine repowers for tugboats and other marine vessels.

Cleaner Fuels. Under State law, all other harbor craft except military vessels will be required to use California diesel fuel beginning in 2006 in South Coast and 2007 statewide. Additional NOx and diesel PM reductions can be achieved using water/diesel emulsions. ARB estimates that emulsified diesel fuel used in on-road engines can reduce NOx by 15 percent and PM by 50 percent. Additional testing is required to determine whether similar reductions are possible in marine engines.

Biodiesel is another alternative fuel option. Biodiesel is derived from vegetable oils or recycled restaurant grease, and can be mixed with diesel fuel or used straight. Pure biodiesel can reduce PM emissions by over 50 percent but generally results in a NOx increase. For this reason, biodiesel is best used in combination with NOx control strategies. Biodiesel manufacturers are also working on additives that can be used to prevent increases in NOx emissions.

The use of compressed or liquefied natural gas or diesel/CNG dual fuel applications can result in significant reductions in NOx and PM. The results vary with specific application and the ratio of diesel to CNG used. Additional testing is required to determine whether similar reductions are possible in marine engines.

Add-On Emission Control Devices. ARB-verified diesel emissions control systems, such as a bolt-on device (like a filter or catalyst) and/or a lower-emission fuel (like a diesel blend or other alternative fuel) have been shown to dramatically reduce emissions when used with heavy-duty diesel engines. ARB has established

requirements for system performance, durability, and warranties to ensure that the equipment works as expected in operation.

- *Diesel particulate filters* (filters) contain a semi-porous material that permits gases in the exhaust to pass through but traps the diesel soot, with a PM control efficiency of 85 percent or more. There are two kinds of filters available – passive and active. Passive filters must be maintained periodically to remove the particles collected on the filter. Active filters clean themselves at the end of the day or shift.

- *Diesel oxidation catalysts* (catalysts) use a catalyst material and oxygen in the air to trigger a chemical reaction that converts a portion of diesel PM and ROG into carbon dioxide and water. Their diesel PM control efficiency is limited to about 30 percent.

- *Selective catalytic reduction* systems work very well on vessels that are designed around the system. This technology reduces NOx to nitrogen and water through the use of a catalyst and a reducing agent (e.g., urea solution). It has been shown to reduce NOx by 65 to 90 percent in many marine applications. Selective catalytic reduction systems are currently used in over 50 marine vessels of various types, primarily in Europe. The system is quite large and consumes a large amount of vessel area, making it a poor candidate for retrofitting.

Other NOx exhaust treatment controls include lean-NOx catalysts and rapidly developing technologies such as NOx adsorbers and plasma-catalyst systems. Controls such as water injection, injection timing retard, exhaust gas recirculation, and humid air motor technology can achieve significant NOx reductions from existing engines. NOx can also be reduced via mechanical changes to the engine, particularly during engine rebuilding. There is an emerging trend in the development of add-on control systems that can control both PM and NOx. For example, combination systems incorporate both filters and selective catalytic reduction, or filters and NOx adsorbers, or add-on controls with cleaner fuels. Applying these technologies to the marine sector is in the demonstration stages. There are several marine demonstration projects currently running on a ferry fleet and naval vessels to determine the feasibility of using land based technology on marine engines.

Status: ARB staff began holding workshops on the approach in 2004. We expect to present a formal proposal to the Board in early 2007.

ii. Shore Based Electrical Power

When not actively guiding incoming or outgoing ships, assist vessels use diesel auxiliary generators to maintain electrical power or simply idle while waiting for another ship to require assistance. Emissions from these auxiliary generators or engine idling can significantly contribute to a port's emissions of NOx and PM. One option to reduce emissions from auxiliary generators while at dock is to allow harbor tugboats, towboats and work boats to use shore power (known as cold ironing) when not actively assisting vessels through the harbor. Harbor tugs would be modified to accept power from shore facilities.

This strategy would require the ports to work with the vessel operators to provide the necessary infrastructure to provide power to run harbor craft while waiting at dock for ships to assist. A necessary component of this concept is to modify the assist tugs and tugboats to accept shore side power. This would make it unnecessary to use auxiliary generators or long periods of engine idling simply to maintain power.

Ports would need to find appropriate space on their property for the infrastructure necessary to install shore side power. This would depend on anticipated demand, and could range from simply cables and dock modifications to dockside substations. Ports could condition operating agreements or leases to require harbor craft to be equipped to utilize shore side power. The feasibility of cold ironing harbor craft is likely dependent on existing electrification for other vessel types such as ships. Another factor is the location of the harbor craft berths in relation to any existing electrification for ships. Ports may be much less likely to commit to infrastructure improvements if electric power is only being installed for harbor craft and no other vessel types.

Some ports will have operational issues that may prevent the same rate of participation by harbor craft, and therefore potential benefits. For example, tugs serving the Port of Oakland may be based and berthed in San Francisco, Oakland, Richmond or elsewhere in the Bay Area. The proximity of harbor craft berths to the ships berths may make implementation in some areas more difficult.

b. Implementation Possible by 2015

i. New Engine Emission Standards

U.S. EPA has proposed[2] standards for new auxiliary marine diesel engines (Categories 1 and 2). The regulation would be modeled after the advanced diesel control technology being developed for on-road trucks and land-based off-road equipment. PM levels would be based on state-of-the-art emission controls such high-efficiency catalytic after-treatment. To date, no technical barriers have been identified that would prevent the transfer of advanced technology engines already required for other sources to marine applications. If U.S. EPA does not adopt more effective new engine standards for harbor craft in the near-term that take advantage of these technology advances, ARB will consider doing so. If California moves ahead, our new standards can then be used as the foundation for equally stringent national standards.

c. Implementation Possible by 2020

Based on the expectation of advanced technology standards (adopted by ARB or U.S. EPA) taking effect by 2015, incentive programs to accelerate early introduction of complying engines would provide additional emission reductions by 2020.

[2] *Federal Register*, Vol.69, No. 124, Tuesday, June 29, 2004 "Control of Emissions of Air Pollution from New Locomotive Engines and New Marine Compression-Ignition Engines Less Than 30 Liters per Cylinder.

4. Emission Reduction Benefits

Table III-5 shows that the strategies described in this plan would ensure that statewide emissions from harbor craft steadily decrease through 2020.

Table III-5
Statewide Emissions from All Harbor Craft*
with Benefits of Plan
(tons per day)

Pollutant	Year				
	2001	2005	2010	2015	2020
Diesel PM					
Emissions with Existing Program	4.2	4.3	4.0	3.9	3.9
New Reductions – Shore-Based Electrical Power	--	--	-0.06	-0.10	-0.10
New Reductions – ARB Rule to Clean Up Existing Engines			-0.98	-1.16	-1.55
New Reductions - New Engine Standards					
New Reductions - Total	0.0	0.0	-1.0	-1.3	-1.7
Emissions with Plan	4.2	4.3	3.0	2.6	2.2
NOx					
Emissions with Existing Program	85.8	86.1	83.9	82.7	82.7
New Reductions – Shore-Based Electrical Power	--	--	-21.0	-24.8	-33.1
New Reductions – ARB Rule to Clean Up Existing Engines	--	--	-1.4	-2.2	-2.1
New Reductions - New Engine Standards					
New Reductions - Total	0.0	0.0	-22.4	-27.0	-35.2
Emissions with Plan	85.8	86.1	61.5	55.7	47.5
ROG					
Emissions with Existing Program	8.7	8.7	8.7	8.6	8.6
New Reductions – Shore-Based Electrical Power	--	--	0.0	0.0	0.0
New Reductions – ARB Rule to Clean Up Existing Engines	--	--	-2.2	-2.6	-3.5
New Reductions - New Engine Standards					
New Reductions - Total	0.0	0.0	-2.2	-2.6	-3.5
Emissions with Plan	8.7	8.7	6.5	6.0	5.1
SOx					
Emissions with Existing Program	0.5	0.5	0.2	0.1	0.1
New Reductions – Shore-Based Electrical Power	--	--	--	--	--
New Reductions – ARB Rule to Clean Up Existing Engines	--	--	--	--	--
New Reductions - New Engine Standards	--	--	--		
New Reductions - Total	--	--	--	--	--
Emissions with Plan	0.5	0.5	0.2	0.1	0.1

* Includes emissions from tugs, ferries, and commercial fishing boats.

D. CARGO HANDLING EQUIPMENT

1. Introduction

The cargo handling equipment sector includes yard trucks, cranes, forklifts, top handlers, side handlers, reach stackers, sweepers, loaders, dozers, excavators, railcar movers, and backhoes, which are used at ports and intermodal rail yards to move goods in containers or in bulk form. This equipment transfers the cargo between ships, trains, trucks, or storage areas within the facility. Equipment may be owned by the facility operator or private companies operating as tenants.

Yard trucks (also referred to as yard tractors, yard goats, hustlers, utility tractor rigs, or yard hostlers) are the most common type of cargo handling equipment at ports – approximately 60 percent of the equipment by number. Yard trucks move trailers carrying containers within ports, rail yards, and distribution centers. Many are operated exclusively within the facility and can be equipped with either on-road or off-road engines.

The next most common types of equipment at ports are: forklifts (which move containers, other equipment, and palletized cargo by sliding prongs underneath them and raising the load), top picks (which are similar to forklifts, but raise containers from the top), rubber-tired gantry cranes (which are very large self propelled units that lift and move containers), and bulk handling equipment (which include tractors, loaders, dozers, excavators, and backhoes that scoop and move uncontained, bulk materials like cement, scrap metal, and petroleum coke). Over 90 percent of this equipment is currently powered by diesel fuel, with the rest (primarily forklifts) operating on gasoline or alternative fuels (such as natural gas, propane, and electricity). The largest stationary cranes used to move containers off ships are often electric.

From a regulatory perspective, this is a complicated category because the wide range of equipment used can be classified as on-road mobile, off-road mobile (diesel or gas powered), stationary, or even portable. Each of these classifications is regulated under a different legal authority and subject to different emission standards.

The majority of the emissions in this sector are from off-road mobile equipment running on diesel fuel, with small contributions from the other types. We identified the emissions from off-road diesel cargo handling equipment used to move imports and exports as the universe of cargo handling emissions addressed quantitatively in this plan. We describe adopted or pending regulations that affect the other types of cargo handling equipment used to transfer goods in California. However, neither the emissions from this other equipment, nor the reductions expected from applicable regulations, are included in our accounting of plan benefits.

California and U.S. emission standards for off-road diesel equipment will significantly reduce emissions from this sector as new, cleaner equipment is phased in. Typical for diesel engines, the primary pollutants of concern from this equipment are diesel PM,

NOx, and ROG. California is authorized under the federal Clean Air Act to regulate most off-road mobile sources of emissions, including cargo handling equipment. In some cases (e.g., applying new engine standards or requiring retrofits of existing engines), the California regulation must be at least as stringent as national requirements, and California would need to obtain U.S. EPA authorization (i.e., a waiver from preemption) to enforce such regulation.

ARB's draft Exposure Assessment Study for the Ports of Los Angeles and Long Beach identifies cargo handling equipment as a high contributor to the total health risks associated with port operations because this equipment operates full time on the port property, rather than passing through like ships, trains, and trucks.

2. Actions Taken Since 2001

ARB and U.S. EPA have adopted the next phase of cleaner technology and fuel requirements for off-road diesel equipment, which will steadily reduce emissions through 2025 as cleaner equipment replaces older equipment. ARB has also acted to cut emissions from other categories of equipment that may be used in small numbers to move goods at ports or rail yards. Complementary actions taken by port operators over the last few years are also accelerating the introduction of cleaner technologies, such as the use of alternative-fueled equipment, the use of alternative diesel fuels, low-sulfur diesel fuel, and the application of diesel emission control systems.

- ✓ Low Sulfur Diesel Fuel Rule. In 2003, ARB adopted a statewide sulfur limit of 15 ppm for diesel fuel for off-road equipment. The standard takes effect statewide in 2006, with accelerated implementation in the South Coast Air Basin as of 2005. The lower sulfur levels are essential to facilitate use of advanced diesel engine control technology.

- ✓ Tier 4 Emission Standards for New Off-Road Engines. In 2004, ARB adopted more stringent emission standards for diesel off-road equipment, including cargo handling equipment covered in this plan and ground support equipment used at airports. This action aligned California's program with U.S. EPA's national standards. These standards for PM, NOx, and ROG will be phased in by the horsepower range of the equipment, from 2008 for small engines, through 2015 for more powerful engines. We expect engine manufacturers to adapt the control technology being developed for 2007 and later on-road trucks to work in these off-road applications.

- ✓ Stationary Diesel Engine Rule. In 2004, ARB adopted a regulation requiring stationary diesel engines (those anchored to a solid foundation like pumps) to meet cleaner emission standards and to use clean fuels. Depending on the use of the engine, beginning in 2005, new engines must meet emission standards at least as stringent as new off-road diesel engines or more stringent standards in the event the engine is not used as an emergency back-up engine. In-use engines are also required to reduce emissions beginning in 2005 through the application of cleaner technologies or by reducing the hours of operation.

- ✓ Portable Equipment Rule. In 2004, ARB adopted a regulation requiring most portable diesel equipment (which can be towed from site to site, but is not self-propelled) to also meet progressively more stringent emission standards. By 2010, existing portable engines must comply with Tier 1, 2, or 3 emissions standards for new off-road equipment. Owners of multiple portable engines need to meet fleet average targets from 2013 through 2020.

- ✓ Incentives for Cleaner Fuels. In 2002, ARB awarded a grant for over $1 million to the Ports of Los Angeles and Long Beach to implement an emulsified diesel fuel program for yard trucks and other equipment.

Table III-6 shows that adopted ARB regulations and other programs are reducing 2001 cargo-handling equipment emissions about 25 percent by 2010, increasing to over 70 percent by 2020.

Table III-6
Statewide Emissions from Cargo Handling Equipment
Used to Move Imports and Exports
with Benefits of All Measures Adopted as of October 2005
(tons per day)

Pollutant	Year					
	2001	2005	2010	2015	2020	2025
Diesel PM	0.8	0.7	0.5	0.4	0.2	0.1
NOx	20.9	18.7	16.0	11.3	6.2	3.9
ROG	2.5	1.9	1.2	0.8	0.7	0.8
SOx	<0.1	<0.1	0.1	0.1	<0.1	<0.1

3. Strategies to Further Reduce Emissions

a. Implementation Possible by 2010

i. ARB Rule for Diesel Cargo Handling Equipment

Cargo handling equipment used at ports and rail yards typically lasts 8 to 24 years before being replaced with new equipment. These long equipment lives mean that the benefits of more stringent emission standards for new engines are slow to accumulate as long as they are dependent on the purchase of new equipment in the normal business cycle. To accelerate the pace of emission reductions and the associated health benefits, ARB staff has proposed a new regulation for mobile cargo handling equipment operating at ports and intermodal rail yards. The proposal seeks to reduce diesel PM and NOx emissions by applying best available control technology.

The advanced control technology is being developed as an integral component of new engine design to meet the off-road diesel Tier 4 standards and as an add-on to be used

with existing equipment. ARB has established requirements to verify the effectiveness, durability, and warranty of diesel emission control systems for existing equipment, such as a bolt-on device (like a filter or catalyst) and/or a lower-emission fuel (like a diesel blend or other alternative fuel). Verified emission control systems reduce diesel PM, or diesel PM plus other pollutants. There are three benchmarks that diesel emission control systems can be verified to – Level 1 (at least 25 percent PM control), Level 2 (at least 50 percent PM control, and Level 3 (at least 85 percent PM control). NOx reduction technology can also be verified, starting at a 15 percent NOx control level. Some technologies have been verified for use on off-road equipment, but there are not yet verified systems for all makes and model years of cargo-handling equipment.

The proposed regulation would generally require all newly purchased, leased, or rented equipment to have either a 2007 or later on-road engine, Tier 4 off-road engine, or cleanest available off-road engine equipped with a verified diesel PM emission control system, beginning January 2007. Alternative fuels are an option to reduce emissions to the required levels. For existing yard trucks, the proposed regulation requires an accelerated phase-in for all vehicles to meet similar requirements. Similar provisions would apply to other types of existing cargo handling equipment. Some cargo handling equipment would be subject to a second step requirement in 2015 to either meet the Tier 4 off-road diesel engine requirements or apply a verified level 3 diesel PM control, depending on the type of equipment and the level of control originally applied.

The proposed regulation would accelerate reductions in diesel PM and NOx emissions faster than would result from normal turnover of the fleet as on-road and Tier 4 off-road standards come into effect. ARB staff estimates a cost effectiveness of $41 per pound of PM reduced. If half of the cost is attributed to NOx reductions, the cost effectiveness for PM would be about $21 per pound and about $1 per pound of NOx reduced.

Average annual costs are expected to be about $5.1 million between 2007 and 2020. Total compliance cost is expected to be about $71 million. Total costs to a typical business between 2007 and 2020 are estimated to be $343,000 to $1,373,000 depending on the number and type of equipment regulated.

Status: ARB staff has been developing a regulation since July 2004. The staff's formal proposal was released on October 21, 2005. The Board is scheduled to consider adoption at its December 2005 meeting.

ii. ARB Rule for Gas Industrial Equipment

ARB staff has also proposed a regulation for industrial equipment typically powered by gasoline or propane, including forklifts. There are small number of these gas forklifts used in cargo-handling at ports and rail yards. The engines in these forklifts are similar to those in cars, but lack the advanced automotive emission controls that have so effectively cut overall vehicle emissions. The proposal would establish tighter NOx and ROG emission standards for new engines, beginning in 2010. It would also set fleet

average requirements for owners of four or more forklifts or other equipment to accelerate the replacement of older equipment, phased in from 2009 through 2013.

Status: The Board heard public testimony on this proposal in June 2005 and will revisit it in 2006.

b. Implementation Possible by 2015

i. Upgrade To 85 Percent Diesel PM Control or Better

The regulation proposed by ARB staff for diesel cargo-handling equipment relies on the best available control technology to achieve significant reductions in diesel PM and NOx emissions starting December 31, 2007. As one of the compliance options for existing equipment (other than yard trucks), it would allow owners and operators to use the most effective diesel PM emission control systems verified by ARB that are available by the applicable compliance date. The most effective control level for verification is a Level 3 system that achieves 85 percent or better control of PM emissions.

If Level 3 control systems are not available by the compliance date, but are later verified, there is a potential opportunity for further reductions. The concept for this strategy is to upgrade the diesel PM controls on all cargo-handling equipment affected by the regulation to 85 percent control or better by 2015, if such an action would be technically feasible and cost-effective in reducing emissions.

ARB staff plans to form a technical working group on cargo handling equipment as part of the implementation effort if the Board adopts the proposed regulation. This working group would be a useful forum to discuss the development of Level 3 diesel emission control systems for existing cargo handling equipment and the effectiveness of requiring a second upgrade to this equipment.

The potential emission reductions would depend on how many pieces of equipment were not already at the 85 percent control level in 2015, and the proportion of engines certified to Tier 1, 2, or 3 standards.

Some verified diesel emission control systems will only reduce diesel PM, while others may also reduce ROG or NOx. For purposes of assessing the potential benefits from this strategy, we used staff's assumptions about the percentage of each type of cargo handling equipment that would be at each expected combination of emission standard tier and diesel emission control system verification level after implementation of ARB's proposed regulation. We assumed only diesel PM would be reduced and that the benefits would last only until the end of the useful life of the equipment, at which time the equipment would be replaced by a new model meeting the Tier 4 standards (at 97 percent PM control).

c. Implementation Possible by 2020

i. Zero or Near-Zero Emission Equipment

Opportunities for additional emission reductions will require the development of new technology for heavy duty off-road equipment, such as reliable and cost-effective electric models that can meet the power requirements, diesel-electric hybrids, or fuel cell technology. The technology is being developed and tested for heavy-duty buses, but substantial resources and time would be required to transfer these technologies to the varied operations of cargo-handling equipment.

The absolute emission reductions from zero or near-zero emission cargo handling equipment would be quite small because the Tier 4 off-road emission standards and the proposed ARB rule for diesel cargo handling equipment reduce emissions to very low levels. Other benefits might include the reduction or elimination of greenhouse gas emissions and reduced dependence on fossil fuels.

4. Emission Reduction Benefits

Table III-7 shows that with the plan strategies, the statewide emissions from cargo handling equipment would be reduced by over 80 percent between 2001 and 2020.

Table III-7
Statewide Emissions from Cargo Handling Equipment
Used to Move Imports and Exports
with Benefits of Plan
(tons per day)

Pollutant	Year				
	2001	2005	2010	2015	2020
Diesel PM					
Emissions with Existing Program	0.8	0.7	0.5	0.4	0.2
New Reductions - ARB Diesel Cargo Handling Rule	--	--	-0.25	-0.24	-0.08
New Reductions - ARB Gas Industrial Equipment Rule	--	--	--	--	--
New Reductions - Upgrade To 85% Diesel PM Control or Better	--	--	--	-0.08	-0.08
New Reductions - Zero or Near Zero Emission Technology					-0.01
New Reductions - Total	--	--	-0.3	-0.3	-0.2
Emissions with Plan	0.8	0.7	0.2	0.1	<0.1
NOx					
Emissions with Existing Program	20.9	18.7	16.0	11.3	6.2
New Reductions - ARB Diesel Cargo Handling Rule	--	--	-3.8	-5.4	-2.0
New Reductions - ARB Gas Industrial Equipment Rule	--	--	--	--	--
New Reductions - Upgrade to 85% Diesel PM Control or Better	--	--	--	--	--
New Reductions - Zero or Near Zero Emission Technology					-0.7
New Reductions - Total	--	--	-3.8	-5.4	-2.7
Emissions with Plan	20.9	18.7	12.2	5.9	3.5
ROG					
Emissions with Existing Program	2.5	1.9	1.2	0.8	0.7
New Reductions - ARB Diesel Cargo Handling Rule	--	--	NQ	NQ	NQ
New Reductions - ARB Gas Industrial Equipment Rule	--	--	--	--	--
New Reductions - Upgrade To 85% Diesel PM Control or Better	--	--	--	--	--
New Reductions - Zero or Near Zero Emission Technology	--	--	--	--	-0.2
New Reductions - Total	--	--	--	--	-0.2
Emissions with Plan	2.5	1.9	1.2	0.8	0.5
SOx					
Emissions with Existing Program	<0.1	<0.1	0.1	0.1	<0.1
New Reductions - ARB Diesel Cargo Handling Rule	--	--	NQ	NQ	NQ
New Reductions - ARB Gas Industrial Equipment Rule	--	--	--	--	--
New Reductions - Upgrade To 85% Diesel PM Control or Better	--	--	--	--	--
New Reductions - Zero or Near Zero Emission Technology	--	--	--	--	<-0.1
New Reductions - Total	--	--	--	--	<0.1
Emissions with Plan	<0.1	<0.1	0.1	0.1	<0.1

E. TRUCKS

1. Introduction

The largest heavy-duty trucks – weighing over 33,000 pounds – travel over 25 million miles daily in California. The vast majority of these trucks are powered by diesel fuel and emit about one-quarter of the motor vehicle NOx and ROG that form ozone and fine particles in the atmosphere, as well as one-fifth of the diesel PM from all sources.

Trucks serving California seaports are a vital part of the goods movement system. Trucks transfer incoming cargo containers from the ports to intermodal distribution centers for transport via long-haul rail or truck to their ultimate destination in California or throughout the U.S. Trucks also carry agricultural products from the Central Valley and other farming regions, and other exports, to the ports for shipment overseas.

The high number of trucks traveling to or from ports through adjacent communities, or into communities to seek services (like fuel and food), can create disproportionate pollution, safety, and nuisance impacts on those communities. Concentrated truck activity near distribution centers and along highway corridors can result in the same negative impacts in adjacent neighborhoods. Reducing the negative impacts to communities can be accomplished by actions such as reducing the number of truck trips required to move goods from the ports, and by stricter enforcement of idling limits, speed limits and parking regulations.

Port-related truck activity is growing. The number of containers carried by truck to and from the Ports of Los Angeles and Long Beach, for example, are expected to grow by a factor of three within twenty years.[3] But despite this growth expected in goods movement activity, California is on a course for substantial reduction in overall heavy-duty truck emissions. This includes vehicles serving our seaports. We expect emissions of all pollutants from heavy trucks to decline by about one-half or more by 2020, as the existing truck fleet slowly turns over to the cleaner engines required by ARB and U.S. EPA regulations. In the case of trucks, we refer to these increasingly stringent emissions standards by the first year that vehicles meeting those standards are introduced. For example, the advanced technologies phased into new trucks between 2007 and 2010 will achieve 98 percent control of both NOx and diesel PM emissions (see Table III-8).

Typically, the truck fleet used for long-distance hauling is newer and cleaner than the trucks used for shorter local or regional trips. Thus, there is a trickle down effect – new trucks are purchased for long-haul trips, the trucks they replace are sold for progressively shorter trips, and the oldest trucks are eventually retired.

[3] *Report to Mayor Hahn and Councilwoman Hahn by the No Net Increase Task Force*, June 24, 2005, p. 2-19.

Most of the short-haul trucks that serve the ports tend to be older and dirtier. Although these trucks would eventually be replaced in the normal course of business, the public health impacts from port-related truck activity need to be mitigated more quickly.

Table III-8
Increasing Stringency of Truck Emission Standards Over Time

Model Year of Engine	Percent Emission Control When Engine Is New	
	NOx	PM
1986 and older	0%	0%
1987 – 1990	44%	0%
1991 – 1993	53%	58%
1994 – 1997	53%	83%
1998 – 2002	63%	83%
2003[4] – 2006	81%	83%
2007 – 2009	90%	98%
2010 and later	98%	98%

ARB programs established since the 2001 starting point for this plan set the next round of emission standards for new engines through 2010, require diagnostic equipment to ensure those engines run clean throughout their lives, accelerate software upgrades for existing engines, restrict idling, and increase enforcement of applicable requirements. New ARB rules in development for trucks will further enhance compliance with existing requirements and tackle the existing fleet. These actions, combined with pre-existing programs, will produce the bulk of the emission reductions from the truck sector through 2020.

2. Actions Taken Since 2001

ARB has already adopted or implemented the majority of the programs needed to cut emissions from the heavy truck fleet through 2020. Complementary actions by U.S. EPA, local air districts and governments, and port operators are further reducing these emissions near ports, distribution centers, and high-traffic corridors.

- ✓ 2007 New Truck Emission Standards. In 2001, ARB adopted a rule that requires 98 percent control of NOx and PM emissions from new heavy-duty truck engines, beginning in 2007. U.S. EPA previously set similar national standards that will affect trucks accessing California ports and distribution centers from other states. To ensure compliance with the new emission standards, ARB in 2004 and 2005 adopted rules requiring increasingly comprehensive on-board engine diagnostic systems, beginning with model year 2007 trucks. During 2006, ARB staff plans to bring a regulation to the Board establishing a manufacturer-run program to monitor

[4] Most model year 2003 trucks meet 2004 engine standards due to "pull-ahead" agreements with truck engine manufacturers.

in-use compliance with the 2007 emission standards by testing the diesel truck engine in place during normal vehicle operation, at various mileage intervals.

- ✓ Vehicle Replacement Incentives. Each year since 1998, the State of California's Carl Moyer Program has been offering monetary incentives to reduce NOx emissions from diesel engines below the levels required by current standards, agreements, and regulations. The most common action has been to replace an older diesel truck with a cleaner diesel or alternative fuel model, resulting in lower NOx and PM emissions. Recent changes to Moyer program guidelines specifically target "vehicles that move goods in and out of ports." The changes also include a longer project life for owners of trucks serving the ports (five years instead of three) to assist truck owners in qualifying for Moyer funds. Several air districts, including those in the Sacramento Region, South Coast, and San Joaquin Valley, have supplemented Moyer incentives to clean up truck fleets with monies from other funding programs.

- ✓ Low Sulfur Diesel Fuel. In 2003, ARB adopted a statewide sulfur limit of 15 ppm for diesel fuel. The standard takes effect statewide in 2006, with accelerated implementation in the South Coast Air Basin as of 2005. New 2007 and later trucks will meet the PM standard with the aid of diesel particulate filters that trap the particles before exhaust leaves the vehicle. This technology only works when sulfur levels in fuel are low.

- ✓ Smoke Inspections for Trucks in Communities. In 2003, ARB shifted its enforcement emphasis from truck weigh stations along freeways to communities heavily impacted by truck traffic. ARB regulations require that diesel trucks and buses not smoke. In 2006, ARB will expand its Environmental Justice Strike Forces by adding more smoke inspectors for trucks serving the Ports of Los Angeles and Long Beach, and operating in the California-Mexico border region.

- ✓ Truck Idling Limits. In 2002, ARB adopted a rule to prohibit trucks from idling within 100 feet of schools. In 2004, ARB adopted a rule to limit engine idling of heavy-duty diesel trucks in California—at ports and elsewhere—to five minutes. This was followed in 2005 by ARB adopting a rule to require trucks equipped with sleeper berths to meet the five-minute limit or use equipment with very low emissions in idle mode.

- ✓ Community Reporting of Violators. ARB maintains a hotline for community members to report excessive idling and smoking vehicles: 1-800-ENDSMOG.

- ✓ Clean Transport Refrigeration Units. In 2004, ARB adopted a rule to cut emissions from transport refrigeration units. These units are diesel-powered engines designed to refrigerate or heat temperature-sensitive products on semi-trailer vans, truck vans, shipping containers, and rail cars. The ARB rule requires all of the units operating in the State (including those registered outside California) to meet progressively more stringent PM standards starting in 2008.

- ✓ Low NOx Software Upgrade. In 2005, ARB adopted a regulation that requires the installation of low NOx software (also called chip reflash) in heavy-duty diesel vehicles with 1993 - 1998 model year engines operating in California, including those registered out-of-state. In the 1990's, engine manufacturers installed computer software on engines that activated emission controls during certification testing to show compliance with the required emission limits, but essentially deactivated the NOx controls during sustained highway driving to increase fuel economy.

As shown in Table III-9, adopted ARB regulations and other programs are reducing 2001 truck emissions over 30 percent by 2010, increasing to around 50 percent by 2020.

Table III-9
Statewide Emissions from Trucks*
Used to Move Imports and Exports
with Benefits of All Measures Adopted as of October 2005
(tons per day)

Pollutant	Year					
	2001	2005	2010	2015	2020	2025
Diesel PM	3.0	2.7	1.6	1.3	1.5	2.0
NOx	128.9	113.7	85.2	63.8	49.8	38.3
ROG	13.6	11.9	9.7	9.2	8.7	8.7
SOx	1.5	1.1	0.7	0.8	1.0	1.1

* Includes emissions from transport refrigeration units.

3. Strategies to Further Reduce Emissions

Additional strategies can be employed to cut emissions from heavy trucks moving goods to and from California seaports. This section describes additional strategies to further reduce the air pollution impacts of truck traffic associated with goods movement, including a comprehensive modernization program for the fleet of trucks serving California's ports. In addition to communities near the ports, this modernization program would also benefits communities on the other end of the truck trip near intermodal rail yards or distribution centers.

a. Implementation Possible by 2010

i. Port Truck Modernization

To design a comprehensive program to modernize the fleet of trucks serving California's ports, we looked at the technical feasibility, relative emission control, and relative cost of three basic upgrade approaches. To understand the options available, we provide a brief discussion of each modernization approach, including its benefits and limitations.

- Retire and Replace – Completely replace an old truck with a newer, cleaner truck powered by a diesel, natural gas, or advanced technology engine. This option works for any vintage of existing truck.

  Replacement can potentially reduce all three pollutants of concern – diesel PM, NOx, and ROG – depending on the age of the vehicle being retired and its replacement (see Table III-8 above). In 2010, we estimate that a seven-year old replacement truck will cost about $43,000. Though expensive, this option delivers substantial emission reductions while eliminating out of service time for the trucker.

- Repower – Keep the truck itself, but replace the existing diesel engine with a brand new, cleaner diesel engine. Depending on the year of the engine being replaced, repowering can reduce all three pollutants of concern – diesel PM, NOx, and ROG. We estimate that purchasing and installing a new engine (if technically feasible) would cost about $40,000 in 2010. Other considerations in repower decisions are the remaining life of the truck chassis and the days or weeks the truck would be lost from service.

  We examined this approach for 1994 and later vintage trucks that were built with electronic control systems (required by new engines), but found that it may not appropriate due to other technical barriers. The more sophisticated engine and control technologies that will be used to comply with the 2007+ standards are designed to work with the truck chassis and other components as a single system. We do not anticipate that engines meeting the 2007+ standards will be available as replacement units for older engines in existing trucks. Since the cost of a new engine represents a significant portion of the value of the truck, repowering is also economically unattractive.

- Retrofit – Keep the existing truck and engine, but add an ARB-verified diesel emissions control system, such as a bolt-on device (like a filter or catalyst) and/or a lower-emission fuel (like a diesel blend or other alternative fuel). Verified emission control systems reduce diesel PM, or diesel PM plus other pollutants. ARB has established requirements for system performance, durability, and warranties to ensure that the equipment works as expected on the road. This is typically the least expensive option. There are verified technologies available for some makes and model years of trucks, but not all. Some of the retrofit devices can provide highly efficient control, but may also require additional maintenance to achieve those levels. Most retrofits can be done in about a day, and can usually be performed while the truck is in the shop for regular maintenance, minimizing time out of service.

  Diesel particulate filters (filters) contain a semi-porous material that permits gases in the exhaust to pass through but traps the diesel soot, with a PM control efficiency of 85 percent or more. These filters are widely available for 1994 and later trucks. There are two kinds of filters available for diesel trucks – passive and active. Passive filters must be periodically maintained to remove the residual material collected on the filter. These filters cost approximately $8,000; additional costs

include one-time custom installation and annual maintenance of about $400. Active filters clean themselves at the end of the day or shift when plugged into an electrical outlet. These filters cost about $14,000 for purchase and installation; there are no annual maintenance costs.

Diesel oxidation catalysts (catalysts) use a catalyst material and oxygen in the air to trigger a chemical reaction that converts a portion of diesel PM and ROG into carbon dioxide and water. These catalysts can be installed on trucks older than 1994, but their diesel PM control efficiency is limited to about 30 percent. These catalysts cost about $1,000 - $1,500 to purchase, plus the cost of installation; there are no annual maintenance costs.

NOx catalysts use a catalytic coating and chemicals in the exhaust to convert NOx to atmospheric nitrogen. They can be used in combination with diesel particulate filters on 1994 - 2003 diesel engines to achieve a 25 percent NOx reduction (in addition to the 85 percent diesel PM reduction). The cost of this combination technology is about $20,000 per truck including installation, plus about $2,000 in maintenance costs over the 10-year life of the system.

Exhaust gas recirculation technologies, verified for certain 1998 - 2002 truck engines, achieve NOx reductions of 40 percent or more, in addition to 85 percent PM and ROG reduction when used in combination with filters.

Selective catalytic reduction technologies reduce NOx to nitrogen and water through the use of a catalyst and a reducing agent (e.g., urea solution). They have achieved NOx reductions of up to 80 percent, but their verification is currently limited to off-road applications. Within several years these technologies are expected to become more proven and available.

After considering all of the above options for port trucks, we are recommending a fairly straightforward strategy to modernize the port truck fleet.

- Replace pre-2003 trucks with 2003 and newer trucks. Due to “pull-ahead” agreements with truck engine manufacturers, most model year (MY) 2003 trucks meet 2004 engine standards (i.e., both PM and NOx are controlled 80 percent or more). We are proposing that by 2010, every truck routinely used in port service meet these standards. We can accomplish this by replacing 4,600 port-serving trucks per year, beginning in 2007, with trucks of model year 2003 or later. The cost of replacing 18,400 trucks by 2010, at a per-unit average cost of $42,600 (2003 models), would be about $780 million.

- Retrofit all pre-2007 trucks with diesel particulate filters. In addition to the 18,400 pre-2003 trucks projected to be in port service in 2010 (to be replaced), staff estimates nearly 3,600 MY 2003-2006 trucks will be serving the ports in 2010. Every pre-2007 truck should be retrofitted with diesel particulate filters to cut PM an

additional 85 percent. Adding particle filters to these 22,000 trucks by 2010 would cost, at $9,610 per unit, about $210 million.

- Retrofit 5,000 additional trucks with PM and NOx controls (by 2015). The portion of the MY 2003-2006 fleet expected to serve the ports can be expected to grow beyond 2010.[5] If the current port truck age distribution prevails in 2015, 8,640 of the nearly 29,000 trucks serving the ports would be 9-12 years old. These trucks should be retrofitted with diesel particulate filters and – if verified technologies are available – catalysts or other devices to reduce NOx. The cost of retrofitting the 5,000 or so additional trucks that were not previously retrofitted, with devices that reduce both PM and NOx, would be about $100 million.

While ARB has the regulatory authority to adopt a fleet rule requiring an accelerated transition to lower-emission trucks, we anticipate that a vast majority of the port truck owners have a single-truck operation and do not generate sufficient revenues to pay the full cost of the recommended upgrade. To succeed, this program would require an alternative funding source to help defer the cost of the replacement trucks and retrofit technologies.

Ideally, a port truck fleet replacement strategy would begin in 2007 and modernize the entire fleet serving ports by 2010 if sufficient funding and used vehicles are available within that time window. But, given the need to secure (or potentially generate) significant new funding to support this program and the introduction of lower emission trucks between 2007 and 2010, it may be necessary and reasonable to extend the implementation of this strategy beyond 2010. After the final implementation date, each port terminal could be responsible for ensuring only compliant vehicles are allowed access to the port to drop off or pick up cargo.

The number of port trucks estimated here is preliminary. ARB staff is conducting a study at the Ports of Los Angeles and Long Beach to better characterize the existing trucks used to serve these ports (the results will also be applied to other ports). The results of this study may change our understanding of the most effective way to structure a modernization program, as well as the associated costs and the appropriate balance of regulatory versus voluntary implementation.

Status. ARB staff's study of port trucks and detailed evaluation of modernization options are underway. We expect results by early 2006. A port truck modernization program could begin as early as 2007 if funding is secured.

[5] The replacement of pre-2003 trucks can be expected to affect the age distribution of trucks not replaced. Though the replacement program may slow turnover to 2007 and later model year trucks, 2003-2006 trucks will already have been purchased at the time the replacement program begins. Still, the impact of the replacement program on the *use* of later model trucks for port service cannot be precisely predicted.

ii. Enhanced Enforcement of Truck Idling Limits

ARB adopted statewide truck idling limits to immediately reduce emissions, especially in communities with high levels of truck activity. ARB's regulations that limit non-essential idling to five minutes and ban idling within 100 feet of schools provide the regulatory tools to address the problem, but compliance with the limit can be enhanced through partnerships with local governments. ARB staff will work with local governments to increase enforcement, which will decrease the pollution and nuisance from idling trucks.

Since the benefits of the idling limits are already included in the emission estimates in this plan, we do not quantify any additional emission reductions from this strategy.

Status. ARB staff will begin by focusing on communities near ports.

iii. International Trucks Meet U.S. Emission Standards

ARB staff is proposing regulations to implement a new provision in State law (AB1009, Pavley, Statutes of 2004) designed to ensure trucks from outside the U.S. that operate in California meet the applicable U.S. emission standards, beginning in 2006. The statute requires the truck operator to carry evidence of compliance.

The proposed regulation addresses emissions from heavy-duty trucks domiciled in Mexico. From 1993 through 2003, Mexican truck emission standards were aligned with the U.S. standards. However, Mexico has not revised its emission standards to reflect the tightening of U.S. standards for 2004 and later engines, or the even more stringent U.S. standards for 2007+ engines. Travel by Mexican commercial vehicles in California may increase upon implementation of the transportation provisions of the North American Free Trade Agreement (NAFTA).

The benefits of this rule for trucks serving the ports are not reflected in this plan because the potential excess emissions are not included in the goods movement inventory. Once the travel restrictions are lifted and we begin to gain some objective data on Mexican truck travel, ARB plans to include the appropriate emissions changes in the inventory.

Status. ARB staff is developing the regulation. The Board is scheduled to consider the regulation at its January 2006 meeting.

b. Implementation Possible by 2015

The port truck modernization program will extend through this period, focusing on PM and NOx retrofits for an estimated 5,000 additional 2003-2006 trucks as they move into port service. As we are designing the port truck modernization program, this effort may require a regulation or port policies to ensure that upgraded trucks are kept in port service and that new entrants use the cleanest trucks.

c. Implementation Possible by 2020

In the post-2015 period, we need to continue to implement the port truck modernization program to ensure that upgraded trucks are kept in port service and that new entrants use the cleanest trucks.

4. Emission Reduction Benefits

As previously discussed, the majority of the emission reductions from the truck sector will come from existing programs, including actions taken between 2001 and October 2005. Table III-10 shows how the new strategies described in this section will further reduce emissions.

Table III-10
Statewide Emission Reductions from Trucks*
Used to Move Imports and Exports
with Benefits of Plan
(tons per day)

Pollutant	Year				
	2001	2005	2010	2015	2020
Diesel PM					
Emissions with Existing Program	3.0	2.7	1.6	1.3	1.5
New Reductions - Port Truck Modernization	--	--	-0.7	-0.5	-0.2
New Reductions – Enhanced Enforcement of Truck Idling Limits	--	--	--	--	--
New Reductions - International Trucks Meet US Emission Standards	--	--	--	--	--
New Reductions - Total	--	--	-0.7	-0.5	-0.2
Emissions with Plan	3.0	2.7	0.9	0.8	1.3
NOx					
Emissions with Existing Program	128.9	113.7	85.2	63.8	49.8
New Reductions - Port Truck Modernization	--	--	-23.9	-15.3	-5.6
New Reductions – Enhanced Enforcement of Truck Idling Limits	--	--	--	--	--
New Reductions - International Trucks Meet US Emission Standards	--	--	--	--	--
New Reductions - Total	--	--	-23.9	-15.3	-5.6
Emissions with Plan	128.9	113.7	61.3	48.5	44.2
ROG					
Emissions with Existing Program	13.6	11.9	9.7	9.2	8.7
New Reductions - Port Truck Modernization	--	--	-1.4	-0.7	-0.2
New Reductions – Enhanced Enforcement of Truck Idling Limits	--	--	--	--	--
New Reductions - International Trucks Meet US Emission Standards	--	--	--	--	--
New Reductions - Total	--	--	-1.4	-0.7	-0.2
Emissions with Plan	13.6	11.9	8.3	8.5	8.5
SOx					
Emissions with Existing Program	1.5	1.1	0.7	0.8	1.0
New Reductions - Port Truck Modernization	--	--	--	--	--
New Reductions – Enhanced Enforcement of Truck Idling Limits	--	--	--	--	--
New Reductions - International Trucks Meet US Emission Standards	--	--	--	--	--
New Reductions - Total	--	--	--	--	--
Emissions with Plan	1.5	1.1	0.7	0.8	1.0

* Includes emissions from transport refrigeration units.

F. LOCOMOTIVES

1. Introduction

Trains have long been considered an efficient way to move goods for long distances. The locomotives that pull trains have powerful, long-lasting engines that typically run on diesel fuel. Trains are an integral part of California's goods movement system, as each container train can replace up to an estimated 250 truck trips.

At this time, moving goods with locomotives generates less pollution than with trucks, but this will not be true in the future unless locomotive engines become significantly cleaner to keep pace with the improvements to truck engines. The average locomotive in 2000 generated less than half of the NOx and PM emissions that the average truck would have generated to move the same ton of cargo the same distance. However, emissions from trucks are being reduced at a faster rate than emissions from locomotives as a result of more stringent truck regulations. We estimate that diesel PM emissions per ton-mile of goods moved by rail will equal or exceed comparable truck emissions by 2015, as new trucks meeting 2007 emission standards start to reduce truck fleet emissions.

The goods movement industry uses two types of locomotives: "line-haul" locomotives, which move large amounts of goods over long distances, and "switching" locomotives, which move rail cars within a facility to set them up for line haul trips or to prepare them for local delivery. Although emissions from each of these two types of locomotive operations differ, all new locomotives, regardless of type, must comply with the same set of emission standards.

Locomotives emit all of the pollutants we are targeting in this plan – diesel PM, NOx, ROG, and SOx. Switching locomotives account for less than five percent of all rail emissions in California, but can have a significant impact on the air quality and health risks in the communities near large yard operations. ARB's 2004 assessment of diesel PM risk levels near the Roseville Rail Yard in Placer County showed that there were localized risks in excess of 500 potential cancer cases per million people exposed, and that over 155,000 people living in the vicinity of the Rail Yard faced an elevated cancer risk due to the rail operations. In contrast, line haul locomotives that travel throughout California emit over 95 percent of statewide rail emissions, but have emissions that are less concentrated and distributed over a much larger area. In California, two freight railroad companies, the Union Pacific Railroad (UP) and the Burlington Northern and Santa Fe Railway (BNSF), account for approximately 95 percent of all railroad emissions, and 99 percent of all goods movement rail emissions.

This plan quantified the emissions from locomotives that move imported and exported cargo, as well as the benefits of new strategies. However, all of the actions taken since 2001 and all of the proposed additional strategies would reduce emissions from locomotives that move domestic goods as well.

Federal law limits the abilities of states and local jurisdictions to control locomotive emissions, or to enforce rules that affect national railroad transportation. Due to these statutory restrictions, states and local agencies have limited authority to require the reduction or mitigation of emissions from locomotives. Rules have to be narrowly and carefully crafted to survive federal preemption, limiting the emission reductions that can be obtained. Attempts to adopt broader regulatory requirements would likely be subject to court challenges that could delay or eliminate the emission benefits. Voluntary agreements with the railroads are a part of the State's strategy because they avoid these delays.

Locomotives last a very long time (30 to 40 years) and railroads typically remanufacture them every seven years. Remanufacturing typically involves rebuilding the locomotive engine back to its original operating specifications. In 1998, U.S. EPA established national emission standards for 1973 and later locomotives. The applicability of these emission standards is based on the original manufacture date for the locomotive, and follows a tiered system similar to those discussed for other sectors.

The most stringent existing standards – Tier 2 – provide a significant reduction in locomotive emissions (over 50 percent NOx control and over 30 percent PM control), but the long life of locomotive engines means that without additional action we would not see the full benefits of these standards until 2030.

To accelerate the introduction of these cleaner Tier 2 locomotives in the South Coast to help meet the former 2010 deadline for ozone attainment, ARB and U.S. EPA entered into an enforceable agreement in 1998 (1998 Agreement) with the two major freight railroads in California - UP and BNSF. The 1998 Agreement requires the railroads to concentrate their cleanest locomotives in the South Coast to achieve a 65 percent reduction in NOx emissions by 2010 (20 years earlier than would have resulted from typical fleet turnover). Since these same cleaner locomotives will travel in other areas of the State, the 1998 Agreement will also significantly reduce NOx emissions statewide.

2. Actions Taken Since 2001

- ✓ Low Sulfur Diesel Fuel Rule. In 2004, ARB adopted a regulation requiring locomotives that operate solely within the State to use California low-sulfur diesel fuel, beginning in 2006 in South Coast and 2007 statewide. When implemented in 2007, this regulation will reduce the allowable sulfur levels in the diesel fuel used by switcher locomotives from 500 ppm to 15 ppm of sulfur.

- ✓ Statewide Railroad Agreement. In 2005, ARB entered into a statewide pollution reduction agreement (2005 Agreement) with the UP and BNSF railroads. The 2005 Agreement is expected to achieve an additional 20 percent reduction in diesel PM emissions near rail yards within three years.

To accomplish this, UP and BNSF have agreed to: phase out non-essential idling and install idling reduction devices, identify and expeditiously repair locomotives with excessive smoke, ensure that at least 99 percent of the locomotives operating in California pass smoke inspections, maximize the use of low sulfur fuel (15 ppm), prepare health risk assessments for 17 major rail yards, work with the local air districts and neighboring communities to identify risk reduction measures, and annually report their plans to implement feasible measures beginning January 2006. The 2005 Agreement establishes enforcement penalties that increase with the number of violations cited against an individual locomotive anywhere in the State. It also provides for significant penalties against the railroads should the railroads fail to implement the agreement.

As shown in Table III-11, the existing control program (both national emission standards and enforceable agreements) will reduce emissions by about 30 percent between 2001 and 2010 and stay relatively constant thereafter.

Table III-11
Statewide Emissions from Locomotives
Used to Move Imports and Exports
with Benefits of All Measures Adopted as of October 2005
(tons per day)

Pollutant	Year					
	2001	2005	2010	2015	2020	2025
Diesel PM	1.8	1.5	1.3	1.2	1.2	1.2
NOx	76.5	59.2	44.8	44.2	44.7	45.3
ROG	4.7	3.7	3.6	3.6	3.6	3.6
SOx	2.7	1.6	0.3	<0.1	<0.1	<0.1

3. Strategies to Further Reduce Emissions

Despite the existing federal requirements for locomotive engines and California's voluntary agreements, we must further reduce emissions from locomotives to meet our air quality goals. This section discusses the most promising strategies available for achieving these reductions. They include the use of new technologies, better operating procedures, and retrofits. Some of these actions can be taken on a statewide level, and others are needed at a national level to promote a unified approach to reducing locomotive emissions.

a. Implementation Possible by 2010

There are several technologies available now to reduce emissions from the existing fleet of locomotives. We describe three approaches below that could be used to achieve additional emission reductions by 2010.

i. Upgrade Engines in Switcher Locomotives

The engines used in locomotives – like those used in other diesel applications – can be rebuilt or replaced several times over the locomotive's lifetime. Replacing older locomotives with cleaner technologies is an attractive option for locomotives used in switching operations. Two alternative technologies have been developed that are likely to provide emission reductions by 2010: diesel-electric hybrid locomotives and the locomotives comprised of multiple off-road diesel engines designed to meet more stringent emission standards than locomotive engines. These are not drop-in technologies; a locomotive is completely rebuilt from the frame up to use these technologies.

Diesel-electric hybrid switch locomotives (e.g. Green Goats) are a proven technology that is already in use at some California rail yards. These engines use the same basic concept as a gas-electric hybrid automobile – a battery pack powers the locomotive, while a small diesel engine runs as needed to keep the batteries charged. Hybrid switch locomotives have significantly reduced diesel PM and NOx emissions, idling time, and fuel use compared to conventional switchers.

Remanufactured switchers are also being powered with two or three (700 hp) Tier 3 non-road diesel engines called gen-sets instead of conventional diesel locomotive engines. The multiple engine design has the flexibility to operate on a single generator for most operations, but engage additional engines for added horsepower when needed. The gen-sets are high-speed engines similar to truck engines that accelerate quickly, while typical locomotives have low to medium speed engines. The lifetime engine activity is distributed equally over all of the gen-sets to prevent one engine from wearing out sooner than the rest. The gen-sets are easily repaired or replaced. Engine replacement occurs roughly every 5 to 10 years depending on the work load which would also allow operators to upgrade to more advanced emission control technologies as they become available in the future. Gen-set locomotive manufacturers report that these locomotives can reduce fuel consumption by 20 to 35 percent.

Texas has recently provided $81 million to fund the replacement of 98 switch locomotives with new locomotives powered by multiple off-road engines. The Sacramento Metropolitan Air Quality Management District and Placer County Air Pollution Control District are helping to fund the purchase of one of these switch locomotives to replace a traditional model at the Roseville Rail Yard.

Each of these options can reduce the PM and NOx emissions generated by a locomotive by up to 80 percent, at a cost of approximately $1 million per locomotive. The speed at which this concept can be implemented will be limited by industry's capacity to build the engines and convert locomotives to use them.

While the pilot projects being implemented are using multiple off-road engines, we believe that even lower-emission on-road diesel engine technology could be applied to projects in the near future to achieve better than 90 percent control.

ii. Retrofit Diesel PM Control Devices on Existing Engines

Two options for add-on parts to existing locomotives are diesel particulate filters and diesel oxidation catalysts. Diesel particulate filters contain a semi-porous material that permits gases in the exhaust to pass through but traps the diesel soot, with a PM control efficiency of 85 percent or more. They have been successfully demonstrated in the laboratory on U.S. locomotives, where they reduced diesel PM emissions by up to 80 percent. Diesel oxidation catalysts use a catalyst material and oxygen in the air to trigger a chemical reaction that converts a portion of diesel PM and ROG into carbon dioxide and water. These catalysts have been shown to reduce diesel PM emissions by 20 to 50 percent. While diesel particulate filters typically need a low-sulfur content fuel to operate effectively, diesel oxidation catalysts are tolerant of higher fuel sulfur contents.

Although a number of projects have been proposed throughout the country, diesel particulate filters and diesel oxidation catalysts have not yet been tested or used in rail yard applications in the U.S. A key question to be addressed is whether the filters can maintain the anticipated level of control and necessary durability over time, particularly in rail yard applications. BNSF and UP will be testing two to four locomotives equipped with diesel particulate filters in California rail yard service in 2006.

iii. Use of Alternative Fuels

Cleaner fuels, including ARB's low-sulfur diesel and alternative fuels, are another option to reduce emissions from locomotives (especially older engines), but there are challenges to cost-effective implementation. The alternative fuels are available, but locomotive engines will need to be altered or retrofitted to use some of them. The infrastructure necessary to supply these fuels on a large scale (in California or throughout the U.S.) could present a significant cost. A partial list of these fuels includes:

- *Alternative Diesel*. There are a number of alternative diesel fuels currently available. These include emulsified diesel fuel and biodiesel. The use of these fuels does not typically require any modifications to the locomotive engine, but would likely require the installation of a separate fueling infrastructure.

  Emulsified diesel is a diesel blend that contains diesel fuel, water and other additives that reduce PM emissions. Biodiesel is derived from vegetable oils or recycled restaurant grease, and can be mixed with diesel fuel or used straight. Pure biodiesel can reduce PM emissions by over 50 percent but generally results in a NOx increase. For this reason, biodiesel is best used in combination with NOx control strategies. Biodiesel manufacturers are also working on additives that can be used to prevent increases in NOx emissions.

- *Natural Gas.* Locomotive engines would require modification to be able to use this fuel, and there are concerns about the storage and safe handling of natural gas.

The installation of a separate rail yard fueling infrastructure would also be required. Natural gas has a lower energy content per unit of fuel than diesel, which would increase fuel consumption, fuel cost, and reduce the locomotive's range between refueling.

- *Fisher-Tropsch Diesel.* This synthetic diesel fuel contains less than 10 ppm sulfur, which directly reduces diesel PM and SOx emissions.

b. Implementation Possible by 2015

The key to significant additional reductions from locomotives is to get new locomotives built with the best available control systems and to induce the railroads to put these engines into service much faster than would ordinarily occur. By 2012, a clean new locomotive could be equipped with advanced emission control technologies capable of controlling diesel PM and NOx emissions by 90 percent (relative to uncontrolled engines). Based on accelerated replacement of the existing locomotive fleet in California (at a rate of 10 percent per year), these clean locomotives could comprise 30 percent of the California fleet by 2015. To realize the benefits from this concept, California needs more stringent national standards and a program to concentrate the cleanest locomotives here. This section discusses each element.

i. More Stringent National Requirements

U.S. EPA is developing new locomotive emission standards, with the formal proposal due in mid-2006 and final rulemaking in mid-2007. ARB has advocated in formal comments[6] to U.S. EPA that any new national locomotive emission reduction program must address both: (1) new locomotives through aftertreatment based standards, anti-idling devices, and on-board diagnostics, and (2) existing locomotives through aggressive rebuild and remanufacture requirements, as well as installation of anti-idling devices on the national locomotive fleet. Because of federal preemptions, the establishment of aggressive national locomotive emission standards is essential. This strategy includes all of the elements that we believe must be part of the federal rulemaking.

- Tier 3 Emission Standards. U.S. EPA is developing new locomotive emission standards, commonly referred to as Tier 3, modeled after the 2007/2010 highway and Tier 4 off-road diesel engine programs. These standards would likely apply to new locomotives manufactured in 2011 and beyond. This technology, based on high-efficiency catalytic aftertreatment, will be enabled by the use of 15 ppm sulfur diesel fuel in the national locomotive fleet beginning in 2012. The application of exhaust emission control technologies in new locomotives could achieve 90 percent control of both NOx and PM emissions.

[6] Letter from Catherine Witherspoon, Executive Officer, ARB, to Margo Oge, Director, U.S. EPA Office of Transportation and Air Quality, August 26, 2004.

- On-Board Diagnostics (OBD). U.S. EPA should adopt an on-board diagnostics requirement for locomotives similar to that used in new cars and trucks. The diagnostics system monitors engine performance, notifies the operator of malfunctions that could increase emissions, and helps ensure proper maintenance.

- Rebuild Tier 0, and Tier 1, and Tier 2 Engines to More Stringent Emission Standards. We also believe U.S. EPA should adopt tougher requirements to reduce emissions from existing engines. The Tier 0 and Tier 1 standards implemented in 2000 and 2002 still apply when locomotives originally built to meet those standards are remanufactured. Engines originally built before 1973 are not required to have any emissions control. U.S. EPA should revise the Tier 0 and Tier 1 standards to ensure that the rebuilt engines reflect the technological improvements that have taken place since the locomotive was manufactured. Engine modifications that are already in use, such as changing the compression ratio, optimizing the turbochargers, modifying fuel injectors, and altering injection timing, could provide cost-effective emission reductions from these older engine configurations. U.S. EPA should also revise the Tier 2 standards to include aftertreatment based retrofit controls on these locomotives when they are remanufactured. More stringent rebuild requirements could potentially achieve a 25 percent reduction in NOx emissions and a 60 percent reduction in diesel PM emissions from the existing fleet.

- Idle Limiting Devices on New and Rebuilt Engines. Idle limiting devices are already being installed on many new locomotives, and can be retrofitted onto existing engines. They are electronic monitoring devices that monitor engine parameters, temperatures, and other conditions for practical opportunities to shut down. Locomotives using these devices are expected to save enough fuel in 5-6 years to pay for the device and installation. The nationwide adoption of idling restrictions would meet both the industry's needs for regulatory certainty and the states' needs for lower emissions. The application of idle limiting devices on locomotives could reduce locomotive idling emissions by 40 percent.

ii. Concentrate Tier 3 Locomotives in California

Normally the benefits of a new locomotive standard – such as the Tier 3 standards discussed above – would be seen over time as older locomotives are retired and replaced with new locomotives. However, California could develop a voluntary agreement with the railroads in 2007 to accelerate the use of Tier 3 or equivalent locomotives in California, beginning in 2012. This is the same approach used in the 1998 Agreement to reduce emissions in the South Coast, which accelerated the emission benefit of U.S. EPA's Tier 2 locomotive engine standards by two decades.

c. Implementation Possible by 2020

We are relying on U.S. EPA to adopt the necessary Tier 3 locomotive engine standards to achieve 90 percent control of diesel PM and NOx. California would continue to implement a program to accelerate replacement of the existing locomotive fleet (at the same rate of 10 percent per year) with new engines meeting Tier 3 standards, such that these clean locomotives comprise 90 percent of the California fleet by 2020. The reductions from this program are reflected as a continuation of the strategies in the prior section.

4. Emission Reduction Benefits

As shown in Table III-12, implementing this plan would reduce statewide locomotive emissions by nearly 90 percent between 2001 and 2020.

Table III-12
Statewide Emissions from Locomotives
Used to Move Imports and Exports
with Benefits of Plan
(tons per day)

Pollutant	Year				
	2001	2005	2010	2015	2020
Diesel PM					
Emissions with Existing Program	1.8	1.5	1.3	1.2	1.2
New Reductions - 2010 Strategies to Reduce Emissions from Existing Fleet	--	--	-0.05	-0.52	-1.05
New Reductions - 2015 Strategies to Set More Stringent National Standards and Concentrate Cleaner Tier 3 Locomotives in California	--	--	--		
New Reductions – 2020 Strategy to Continue Concentrating Tier 3 Locomotives in California	--	--	--	--	
New Reductions - Total	--	--	-0.1	-0.5	-1.0
Emissions with Plan	1.8	1.5	1.2	0.7	0.2
NOx					
Emissions with Existing Program	76.5	59.2	44.8	44.2	44.7
New Reductions - 2010 Strategies to Reduce Emissions from Existing Fleet	--	--	-1.7	-22.2	-36.0
New Reductions - 2015 Strategies to Set More Stringent National Standards and Concentrate Cleaner Tier 3 Locomotives in California	--	--	--		
New Reductions – 2020 Strategy to Continue Concentrating Tier 3 Locomotives in California	--	--	--	--	
New Reductions - Total	--	--	-1.7	-22.2	-36.0
Emissions with Plan	76.5	59.2	43.1	22.0	8.7
ROG					
Emissions with Existing Program	4.7	3.7	3.6	3.6	3.6
New Reductions - 2010 Strategies to Reduce Emissions from Existing Fleet	--	--	-0.1	-1.3	-3.0
New Reductions - 2015 Strategies to Set More Stringent National Standards and Concentrate Cleaner Tier 3 Locomotives in California	--	--	--		
New Reductions – 2020 Strategy to Continue Concentrating Tier 3 Locomotives in California	--	--	--	--	
New Reductions - Total	--	--	-0.1	-1.3	-3.0
Emissions with Plan	4.7	3.7	3.5	2.3	0.6
SOx					
Emissions with Existing Program	2.7	1.6	0.3	<0.1	<0.1
New Reductions - 2010 Strategies to Reduce Emissions from Existing Fleet	--	--	--	--	--
New Reductions - 2015 Strategies to Set More Stringent National Standards and Concentrate Cleaner Tier 3 Locomotives in California	--	--	--		
New Reductions – 2020 Strategy to Continue Concentrating Tier 3 Locomotives in California	--	--	--	--	
New Reductions - Total	--	--	--	--	--
Emissions with Plan	2.7	1.6	0.3	<0.1	<0.1

G. OPERATIONAL EFFICIENCIES

1. Efficiency Improvements

Improving the efficiency of the systems and equipment designed to move cargo can reduce the need for infrastructure improvements, lower the emissions per unit of cargo, and decrease the cost of delivery. We discuss a few examples of approaches to increase port efficiency that may warrant further study. Another approach to decrease the need for infrastructure at the major ports is to shift some of the expected growth to underutilized smaller ports that have excess capacity.

a. Empty Container Logistics for Trucks

Only an estimated two percent of the empty import containers handled by local short haul truckers are reloaded with outbound cargo ("street turned"). For a variety of reasons only a small portion of the empty containers can ever be reused for export loads. The potential for expanded reuse may be roughly 5-10 percent. While an increase from 2 percent to 5 percent or 10 percent does not appear dramatic, the large number of containers at stake can create a substantial impact.

Chassis logistics are a major limiting factor in empty container logistics. Even when an ocean carrier operator has no immediate need for a specific empty container to be returned to the port, it may have a pressing need to use the attached chassis for another shipment.

Two options to reduce truck trips involving empty containers are:

- Increasing the current two percent reuse (i.e., using emptied import containers to transport export-bound goods back to the port).

- Implementation of depot-direct off-hiring where all local trucks would be directed to an off-port container depot rather than directly to the port. The container depot would match incoming and outgoing containers to reduce the number of empty container trips into the port. A Southern California Association of Governments study found that such a truck depot would reduce truck trips, overall. However, the benefits of reduced "empty container" trips may be somewhat offset by the shift of truck traffic from the port to the off-port depot.

Use of the Internet is essential to provide more information and help match containers and increase efficiency. The Port of Oakland has launched an Internet-based, container logistics service to reduce the congestion and emissions associated with empty container trips.

Container logistics are complex, however, and successful implementation requires considerable coordination and agreement among multiple parties such as motor carriers, ocean carriers, leasing companies, and chassis pool operators.

b. Speed Loading and Unloading of Vessels

Cargo ships emit substantial emissions from their auxiliary engines while hotelling at the terminal during loading and unloading. A decrease in hotelling times through faster, more efficient cargo handling strategies can also reduce emissions. Terminal delays can be reduced through the use of advanced information technologies and expanded operating hours

c. Automated Cargo Handling

Yard trucks are used to move containers from one location to another in the port. Containers are moved multiple times while they are on terminal property. The fewer times a container is moved, the lower the emissions associated with its transit through the port. Container moves can be reduced through:

- Technology-dependent options, such as installing automated and electrified container-moving equipment on a rail system within the container storage areas.

- Computerized tracking and management practices that allow containers to move from the ship directly onto the trains or trucks that move them from the port.

The emission reductions associated with reduced cargo handling efforts may be minimal after 2015 due to current emission standards and ARB's proposed cargo handling equipment rule that speeds up the replacement of older engines with newer, cleaner engines.

2. Transport Mode Shifts

Shifting the mode of transport of containers from trucks to trains can realize emission reductions through 2012. However, starting in 2015 a majority of the truck fleet will meet 2007 emission standards and trucks will become the cleaner option unless more stringent emission standards for trains are implemented. Examples of mode shift projects that are in place or have been suggested are:

a. Port of Oakland

The Joint Intermodal Terminal at the Port of Oakland provides railroads direct access to the port. This access reduces the number of short truck trips over local roads to the rail yard and from the rail yard to the port. The Bay Area Metropolitan Transportation Commission's Regional Goods Movement Study states that there is growing interest in using the rail network as an alternative connection to the San Joaquin Valley.

b. City of Shafter Inland Intermodal Center

Under this proposal, goods moved from the Port of Oakland to Southern California would be diverted to an inland route utilizing a train shuttle service from the Port of Oakland to the City of Shafter (near Bakersfield), and transferred to trucks for the remainder of the journey to Southern California destinations. Empty containers located in warehousing facilities in the southern Central Valley would be re-used for moving agricultural products bound for the Port of Oakland. This project would require some capital investment to complete connections, but by-and-large the rail lines already exist.

Project proponents estimate that some 80,000 truck trips annually would be eliminated by shuttling goods to the Shafter Intermodal Center. They identify environmental benefits associated with reduced truck congestion during loading and unloading operations at the Port, reduced shipping delays and queuing of marine vessels awaiting berthing at the Port, reduced emissions from trucks that would otherwise operate on congested freeways, and reduced emissions from more efficient management of containers returning to the Port.

c. Ports of Los Angeles and Long Beach

Approximately 18 percent of all containers moving through the Ports of Los Angeles and Long Beach are transferred to and from trains at rail yards that are located on or very near the marine terminal. Other containers are transferred by truck to trains at rail yards that are located four to twenty miles from the ports. The truck traffic to and from these off-port rail yards can be reduced by increasing the use of on-dock rail yards. In the long run, major infrastructure improvements would be required to accommodate increases in on-dock transfers to trains; however in the short term, ports are looking to increase the amount of containers loaded onto trains at the dock by:

- Working with the railroads to assure timely availability of loading equipment and rail crews.
- Working to improve the productivity of loading and unloading of rail cars.
- Maximizing the number of rail cars loaded on dock.
- Preventing storage of containers on rail lines at on-dock terminals.[7]

d. Shifting from Trucks to Barges

An option that is often discussed to reduce the need for more infrastructure and to help absorb the anticipated growth in container shipping is to utilize California's smaller and inland ports as distribution satellite centers for the larger ports. These ports are often underutilized or are experiencing a declining customer base as the trend moves toward

[7] Southern California Association of Governments, *Southern California Regional Goods Movement Policy Paper*, pp. 17-18.

larger container ships. Containers would be brought to these ports by barges that are loaded at the larger ports. The distance that would have been covered by trucks (or rail) carrying containers traveling in the direction of these smaller or inland ports would be covered by the barges. The containers would then be loaded onto trucks for further distribution throughout the state at the smaller satellite ports. To provide an air quality benefit, these barges would need to be equipped with effective emission controls.

H. LAND USE DECISION-MAKING

Land use decisions are a local government responsibility, and we believe local government has a role in preventing avoidable air pollution exposures that pose a health risk. People who live close to major sources of pollution are exposed to greater concentrations of harmful emissions, and therefore are at greater health risk. Recent studies have shown that public exposure to air pollution can be substantially elevated near some sources of pollution, but health risks are greatly reduced with distance. Goods movement-related facilities like ports, rail yards, and freeways are major sources of harmful air pollution, and land use decision makers should use caution when considering siting sensitive land uses such as new residences, schools, day care centers, playgrounds and medical facilities near these types of sources. Community members who live close to goods movement facilities have emphasized that it is important not only to have cleaner ships, trains, and trucks, but also to apply other exposure-reducing safeguards such as buffer zones that keep people away from the greatest concentrations of pollutants. There are also other opportunities for local government to play a positive role, such as limiting the routing of trucks through neighborhoods.

To assist local land use decision makers, the Board approved the “Air Quality and Land Use Handbook: A Community Health Perspective” in 2005. The purpose of the document is to highlight the potential health impacts associated with proximity to air pollution sources so local government can explicitly consider this issue in permitting and planning processes. The Handbook includes specific recommendations regarding the siting of new sensitive land uses near freeways, distribution centers, rail yards, ports, refineries, chrome plating facilities, dry cleaners, and gasoline dispensing facilities. In addition to source specific recommendations, the Handbook encourages land use agencies to use their planning processes to ensure the appropriate separation of polluting sources and sensitive land uses. While the Handbook provides suggestions, the decision as to how best achieve that goal is a local issue.

The Handbook was developed with extensive input from community and environmental groups, business organizations, local air districts and other state and local agencies involved in the land use planning process. It is now beginning to be used by consultants, developers, neighborhood groups, and planners to design projects that rely on separation and other protective measures to reduce health risks caused by nearby pollution sources.

Land use agencies can use each of their existing planning, zoning, and permitting authorities to address the potential health risk associated with new projects such as residential development near ports related facilities. Local agencies can help address localized and cumulative impacts of port related facilities on communities by using their authority to separate residential or other sensitive land uses from sources of air pollution or to require mitigation where separation is not feasible.

Under this strategy, we recommend that land use agencies do the following:

- In developing of General Plans, consider land use compatibility and the cumulative impacts of multiple polluting sources specifically those that are port-related.

- In developing zoning ordinances, ensure that private development takes place such that land uses are compatible. For example, do not locate truck support facilities such as refueling stations or other truck services in residential areas. Seek ways to keep trucks from driving through communities for services.

- In the siting of new sensitive land use projects such as residences, consider strategies to separate these uses from port-related facilities and avoid siting new sensitive land uses immediately downwind of ports in the most heavily impacted zones.

Combined with the emission reductions from regulations and incentive programs, planning decisions are critical in helping to reduce community exposure to port related emissions.

I. PROJECT AND COMMUNITY SPECIFIC MITIGATION

The primary strategies in this plan reflect the authorities and responsibilities of the Air Resources Board and U.S. EPA to reduce emissions from trucks, locomotives, ships, harbor craft, and cargo handling equipment. The main mechanism for achieving these reductions is regulatory action and incentive programs. These comprehensive strategies will provide statewide public health benefits. Implementation of the plan will help regions meet air quality standards, and provide relatively greater benefits in communities near ports and rail yards where the emissions are now concentrated.

It is also important to recognize that other government agencies and those in the goods movement industry have roles to play in terms of mitigating environmental and other community impacts. As new infrastructure projects to support goods movement are developed, environmental mitigation is an essential component. Environmental review provisions of State and federal law provide the legal framework for development of environmental mitigation where government approvals are required for a project. These processes provide an opportunity for public input from communities. Community input is also important where formal environmental review and government approval is not required. For communities already impacted by nearby air pollution sources,

community consultation is especially important where new projects or expansions would significantly increase environmental impacts.

At the project level, it will be important to mitigate the impacts of new infrastructure and other projects. Early consultation with communities can help identify potential mitigation measures of most importance in a particular location. For major expansions related to goods movement, development of a community benefits agreement may be a mechanism to address environmental and other community impacts.

Mitigation efforts tailored to specific communities or projects are an important complement to ARB's statewide strategies. The general concepts outlined in the plan for statewide application – especially the use of cleaner diesel engines and cleaner fuels – may be feasible earlier in targeted situations. This provides opportunities for site-specific mitigation prior to full implementation of the strategies on a statewide basis. This would help mitigate community impacts as quickly as possible with a priority on the most impacted areas. Mitigation of existing impacts near individual rail yards is an example of the need to address health risk in specific communities. Project oriented mitigation is essential to address impacts of any new infrastructure projects. Linking appropriate mitigation to such projects is especially critical in areas where emissions are already concentrated.

J. SUMMARY OF STRATEGIES

This section presents summary information on all of the emission reduction strategies discussed in this plan, including a complete listing of strategies and the emission reductions that would result from implementation.

1. List of Strategies and Implementation Timeframes

Table III-13 lists the measures adopted since 2001 plus new strategies described in this plan to reduce emissions from ports and international goods movement. The table also shows when each adopted measure is scheduled for implementation and when each new strategy could begin implementation.

Table III-13
List of Strategies to Reduce Emissions from Ports and International Goods Movement

Strategy	Status (Adopted or New Strategy)	Implementation Could Begin By		
		2010	2105	2020
SHIPS				
Vessel Speed Reduction Agreement for Southern California	2001	✓		
U.S. EPA Main Engine Emission Standards	2003	✓		
U.S. EPA Non-Road Diesel Fuel Rule	2004	✓		
ARB Rule for Ship Auxiliary Engine Fuel	New	✓		
Cleaner Marine Fuels	New	✓	✓	✓
Emulsified Fuels	New	✓	✓	✓
Expanded Vessel Speed Reduction Programs	New	✓	✓	✓
Install Engines with Emissions Lower than IMO Standards in New Vessels	New	✓	✓	✓
Dedicate the Cleanest Vessels to California Service	New	✓		
Shore Based Electrical Power	New	✓		
Extensive Retrofit of Existing Engines	New		✓	✓
Highly Effective Controls on Main Engines and Existing Engines	New		✓	✓
Sulfur Emission Control Area (SECA)	New		✓	
Expanded Use of Cleanest Vessels in California Service	New		✓	
Expanded Shore Power and Alternative Controls	New		✓	
Full Use of Cleanest Vessels in California Service	New			✓
Maximum Use of Shore Power or Alternative Controls	New			✓
COMMERCIAL HARBOR CRAFT				
Incentives for Cleaner Engines	2001-2005	✓		
ARB Low Sulfur Diesel Fuel Rule	2004	✓		
ARB Rule to Clean Up Existing Engines	New	✓		
Shore Based Electrical Power	New	✓		
New Engine Emission Standards	New		✓	

Strategy	Status (Adopted or New Strategy)	Implementation Could Begin By		
		2010	2105	2020
CARGO HANDLING EQUIPMENT				
Incentives for Cleaner Fuels	2001-2005	✓		
ARB Low Sulfur Diesel Fuel Rule	2003	✓		
ARB/U.S. EPA Tier 4 Emission Standards	2004	✓		
ARB Stationary Diesel Engine Rule	2004	✓		
ARB Portable Diesel Equipment Rule	2004	✓		
ARB Rule for Diesel Cargo Handling Equipment	New	✓		
ARB Rule for Gas Industrial Equipment	New	✓		
Upgrade to 85 Percent Diesel PM Control or Better	New		✓	
Zero or Near Zero Emission Equipment	New			✓
TRUCKS				
ARB/U.S. EPA 2007 New Truck Emission Standards	2001	✓		
Vehicle Replacement Incentives	2001-2005	✓		
ARB Truck Idling Limits	2002-2005	✓		
ARB Low Sulfur Diesel Fuel Rule	2003	✓		
ARB Smoke Inspections for Trucks in Communities	2003	✓		
ARB Transport Refrigeration Units Rule	2004	✓		
ARB Low NOx Software Upgrade Rule	2005	✓		
Port Truck Modernization	New	✓	✓	
Enhanced Enforcement of Truck Idling Limits	New	✓		
Ensure International Trucks Meet U.S. Emission Standards	New	✓		
LOCOMOTIVES				
ARB Low Sulfur Diesel Fuel Rule	2004	✓		
ARB 2005 Agreement with Railroads to Cut PM Statewide	2005	✓		
Upgrade Engines in Switcher Locomotives	New	✓		
Retrofit Diesel PM Control Devices on Existing Engines	New	✓		
Use of Alternative Fuels	New	✓		
More Stringent National Requirements	New		✓	
Concentrate Tier 3 Locomotives in California	New		✓	
OPERATIONAL EFFICIENCY				
Efficiency Improvements	New	✓	✓	✓
Transport Mode Shifts	New	✓	✓	✓
LAND USE DECISIONS	New	✓	✓	✓
PROJECT AND COMMUNITY SPECIFIC MITIGATION	New	✓	✓	✓

2. Emission Reductions with Plan Strategies

This section summarizes the statewide reductions and resulting emissions after implementation of the strategies in this plan for 2010, 2015, and 2020. Table III-14, III-15, III-16, and III-17 show the emissions for each pollutant and each source sector after implementation of the strategies in this plan.

Table III-14
Statewide Diesel PM Emissions from Ports and International Goods Movement with Plan Strategies
(tons per day)

Diesel PM	Year				
	2001	2005	2010	2015	2020
Ships	7.8	10.0	8.7	5.0	6.1
Harbor Craft	4.2	4.3	3.0	2.6	2.2
Cargo Handling Equipment	0.8	0.7	0.2	0.1	<0.1
Trucks	3.0	2.7	0.9	0.8	1.3
Locomotives	1.8	1.5	1.2	0.7	0.2
Total	**17.6**	**19.2**	**14.0**	**9.2**	**9.8**

From 2001 levels, statewide diesel PM emissions would be reduced 20 percent by 2010, 48 percent by 2015, and 44 percent in 2020, despite growth in international cargo.

Table III-15
Statewide NOx Emissions from Ports and International Goods Movement with Plan Strategies
(tons per day)

NOx	Year				
	2001	2005	2010	2015	2020
Ships	94.4	116.9	123.6	89.9	77.8
Harbor Craft	85.8	86.1	61.5	55.7	47.5
Cargo Handling Equipment	20.9	18.7	12.2	5.9	3.5
Trucks	128.9	113.7	61.3	48.5	44.2
Locomotives	76.5	59.2	43.1	22.0	8.7
Total	**406.5**	**394.6**	**301.7**	**222.0**	**181.7**

From 2001 levels, statewide NOx emissions would be reduced 26 percent by 2010, 46 percent by 2015, and 55 percent by 2020, despite growth in international cargo.

Table III-16
Statewide ROG Emissions from Ports and International Goods Movement with Plan Strategies
(tons per day)

ROG	Year				
	2001	2005	2010	2015	2020
Ships	2.5	3.1	3.7	4.6	6.1
Harbor Craft	8.7	8.7	6.5	6.0	5.1
Cargo Handling Equipment	2.5	1.9	1.2	0.8	0.5
Trucks	13.6	11.9	8.3	8.5	8.5
Locomotives	4.7	3.7	3.5	2.3	0.6
Total	**32.0**	**29.3**	**23.2**	**22.2**	**20.8**

From 2001 levels, statewide ROG emissions would be reduced 28 percent by 2010, 32 percent by 2015, and 35 percent by 2020, despite growth in international cargo.

Table III-17
Statewide SOx Emissions from Ports and International Goods Movement with Plan Strategies
(tons per day)

SOx	Year				
	2001	2005	2010	2015	2020
Ships	58.6	75.4	41	14.9	15.9
Harbor Craft	0.5	0.5	0.2	0.1	0.1
Cargo Handling Equipment	<0.1	<0.1	0.1	0.1	<0.1
Trucks	1.5	1.1	0.7	0.8	1.0
Locomotives	2.7	1.6	0.3	<0.1	<0.1
Total	**63.3**	**78.6**	**42.3**	**15.9**	**17.0**

From 2001 levels, statewide SOx emissions would be reduced 33 percent by 2010, 75 percent by 2015, and 73 percent by 2020, despite growth in international cargo.

Table III-18
Statewide Emissions of All Pollutants from Ports and International Goods Movement with Plan Strategies
(tons per day)

Pollutant	Year					Percent Reduction 2001-2020
	2001	2005	2010	2015	2020	
Diesel PM	17.6	19.2	14.0	9.2	9.8	44%
NOx	406.5	394.6	301.7	222.2	181.7	55%
ROG	32	29.3	23.2	22.2	20.8	35%
SOx	63.3	78.6	42.3	15.9	17.0	73%

Table III-19 shows the projected future year emissions with the existing control program, the emission reductions from implementation of plan strategies, and the resulting emissions.

Table III-19
Summary of Statewide Emission Reductions from Ports and International Goods Movement with New Plan Strategies
(tons per day)

Pollutant		Year		
		2010	2015	2020
Diesel PM	Emissions with Existing Program	20.0	22.7	27.5
	Reductions from New Strategies	-6.0	-13.5	-17.7
	Emissions with Plan	14.0	9.2	9.8
NOx	Emissions with Existing Program	373.2	379.3	406.1
	Reductions from New Strategies	-71.5	-157.3	-224.4
	Emissions with Plan	301.7	222.2	181.7
ROG	Emissions with Existing Program	26.9	26.8	27.7
	Reductions from New Strategies	-3.7	-4.6	-6.9
	Emissions with Plan	23.2	22.2	20.8
SOx	Emissions with Existing Program	96.8	122.1	158.7
	Reductions from New Strategies	-54.5	-106.2	-141.7
	Emissions with Plan	42.3	15.9	17.0

K. PORT PROGRAMS TO REDUCE EMISSIONS

Each of California's three major ports is undertaking initiatives to help reduce emissions in and around the ports. In addition, local municipalities are also partnering with regulatory bodies to develop emission reduction programs.

Port of Los Angeles

Environmental Policy and *Community Advisory Committee* - In October 2001, the Port of Los Angeles's Board of Harbor Commissioners announced a new environmental policy "that there will be no net increase in air emissions or traffic impact from future port operations." They also formed a Port Community Advisory Committee to assess the impacts of Port developments on nearby communities; to recommend suitable mitigation measures; to review past, present, and future Environmental Impact Reports; and to provide a public forum for discussing port concerns. Over the past five years, the Port has undertaken several initiatives to reduce air pollution, including the installation of diesel oxidation catalysts on yard tractors, the use of emulsified diesel fuel, accelerated replacement of yard equipment, use of shore-based electrical power while

ships and tugs are at dock, use of cleaner alternate fuels in port equipment, and investment in operational efficiencies.

"No Net Increase Task Force" - In 2004, former Mayor Hahn convened a "No Net Increase Task Force" charged with identifying measures that need to be implemented to demonstrate no net increase of emissions. The Port of Los Angeles No Net Increase goal is equivalent to the first goal of this statewide plan – to reduce port emissions back to 2001 levels by 2010. ARB participated on the Taskforce and the Final Plan was released in June 2005. The plan contains 68 adopted or proposed international, federal, state and local emission reduction measures.

China Shipping Terminal Settlement – In 2004, the Natural Resources Defense Council negotiated a settlement with China Shipping to use low-emission technologies in the company's new terminal at the Port of Los Angeles, as well as other community mitigation actions. These technologies include use of shore-based electrical power for 70 percent of ships at the terminal and use of alternative fuel yard tractors at the terminal.

Port of Long Beach

Green Port Policy – In August 2005, the Port of Long Beach launched its Green Port Policy that aims at reducing air emissions per ton of cargo handled. Programs outlined in this policy include: a voluntary vessel speed reduction program, a goal to provide shore power at all container terminals, various clean fuel and clean engine efforts, and clean switcher locomotive programs. The Port has added catalysts to over 600 pieces of cargo handling equipment, 200 of those pieces using emulsified fuel, and another 100 pieces using ethanol blended diesel fuel.

Green Flags Incentive Program – The Port is developing a program to reward ship and harborcraft owners by reducing dock fees when the ships comply with the vessel speed reduction program. The goal is to get 100 percent compliance with the program.

Smoke Stack Emissions Reduction Program – The Long Beach Harbor Patrol staff is trained to report ships and harborcraft that emit black smoke from their smoke stacks.

Joint Port of Los Angeles and Port of Long Beach Programs

Gateway Cities Clean Air Program – This program provides financial incentives to reduce diesel emissions in Southern California. It includes funding from ARB, U.S. EPA, the South Coast Air District's Mobile Source Review Committee, and the Ports of Los Angeles and Long Beach.

PierPass Program – In July 2005 the ports of Los Angeles and Long Beach launched the PierPass program. With PierPass, a "traffic mitigation fee" is charged based on container size. The fee is refunded if the shipping company moves the container during off-peak hours. Expanding port hours helps to reduce congestion at the terminal.

Switcher Locomotive Program – This program will replace 18 harbor locomotive engines with various emission reduction strategies. The emission reduction strategies include re-powering with Tier 2 engines, liquefied natural gas engines, using emulsified fuel, and installing diesel oxidation catalysts. All of the engines will include a device that limits idling to 15 minutes. These changes will eliminate almost 0.5 tons per day of NOx and 0.008 tons per day of PM.

Port of Oakland

Vision 2000 Maritime Development Program - In 2000, the Port of Oakland released the Vision 2000 Maritime Development Program which included the expansion plan for the port including new marine terminals, roadways, a rail yard park, and associated facilities. An Air Quality Mitigation Program was also put in place to mitigate potential air quality impacts of the expansion. The Program calls for reducing emissions from many port sources. The approaches include: emulsified diesel fuel for transport trucks, repowering tugboats and local transit buses, and replacement, repowering, or retrofitting of diesel truck and cargo equipment that operate at the Oakland facility.