



Emission Reduction Incentives for Off-Road Diesel Equipment Used in the Port and Construction Sectors

Final Report

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EXECUTIVE SUMMARY

This report describes and assesses incentive programs to reduce emissions from off-road diesel engines used in the construction industry and port sector. The report focuses primarily on grant programs, tax incentives, modified contracting procedures, and non-monetary incentives implemented at the federal, state, regional, and local level. For this report we reviewed incentive program information from public agencies, interviewed public and private sector stakeholders, and reviewed other related literature.

This report was prepared for the U.S. Environmental Protection Agency's (EPA) Sector Strategies Program, which works with specific industry sectors (including ports and construction) to address the most significant impediments to better environmental performance in each sector. The report is intended to help the port and construction sectors overcome regulatory, economic, and other barriers that impede the adoption of cleaner off-road diesel technologies. This report will also inform the efforts of the Clean Diesel and Retrofit Workgroup, which is a part of the Mobile Sources Technical Review Subcommittee of the Clean Air Act Advisory Committee, a federal advisory committee that provides advice to EPA on air pollution issues. The Retrofit Workgroup is developing recommendations on incentives that could be pursued at the federal level to expand EPA's current voluntary diesel reduction programs to include other industry sectors, and it has identified the port and construction sectors as good candidates for participation in EPA's voluntary programs.

Background

Diesel engines power much of the world's off-road vehicles, equipment, and vessels. The power, durability, and efficiency of the diesel engine make it suitable for use in a wide range of applications in agriculture, construction, mining, and freight movement. At ports, off-road equipment can include on-dock cargo handling equipment, harbor vessels, oceangoing vessels, and railroad locomotives. Off-road engines used by construction companies are found in a wide variety of loaders, dozers, excavators, graders, and other specialized equipment. Diesel engines are also a major source of air pollution, particularly emissions of nitrogen oxides (NO_x), particulate matter (PM), sulfur oxide gases (SO_x), and toxic air pollutants, all of which contribute to serious adverse health and environmental effects.

EPA is taking steps to reduce emissions from new diesel engines in off-road use by adopting emission standards for most off-road diesel equipment, railroad locomotives, and U.S.-flagged marine vessels. However, emissions from off-road diesel engines will continue to be a major source of air pollution and related health and environmental effects for a number of years because:

1. The most stringent off-road emission standards for new equipment will not fully take effect for at least a decade.
2. Off-road diesel equipment can last 20 to 30 years, and sometimes even longer, so even after the most stringent emissions standards for new equipment come into effect, it will take many years before the bulk of the off-road fleet meets these standards.
3. EPA has no authority to regulate foreign-flagged marine vessels.
4. Construction and port activity will continue to grow as the U.S. economy expands. At many U.S. seaports involved in international trade, freight activity is growing much faster than the U.S. economy. The cruise industry is also expanding rapidly at some ports.

Thus, there is an urgent need to reduce emissions from off-road diesel engines in use today and those that will be manufactured over the next five to eight years. Numerous technological and operational strategies are available to curb off-road diesel emissions. Technological strategies include:

- Retrofits with exhaust after-treatment devices
- Use of alternative fuels
- Repowering (engine replacement)
- Scrapping and replacing older equipment
- Engine repairs and rebuilds to maximize performance

Operational strategies to reduce diesel emissions in the port and construction sectors include:

- Reducing engine idling
- Reducing ship speed
- Greater use of on-dock rail
- Improvement to port gate operations (including improved logistics to reduce truck queuing)
- Cold ironing (vessel connection to shore-side electric power)
- Productivity improvements

EPA has a number of on-going initiatives that support efforts to reduce emissions from diesel engines. For example, EPA oversees the Environmental Technology Verification (ETV) process, which certifies the emission reductions that can be achieved using a particular technology in a specific application. EPA's SmartWay Transport partnership provides recognition to freight carriers and freight shippers that commit to improve the environmental performance of their freight delivery operations related to greenhouse gases. And EPA administers a variety of grant programs, as described in the next section.

Federal, State, and Local Grant Programs

Grant programs provide funding directly to equipment owners to allow them to purchase cleaner equipment, cleaner engines, after-treatment retrofits, or cleaner fuels. In most cases, grant programs attempt to cover the incremental cost of a lower emissions technology. Grants programs are run by EPA, states, regional air quality districts, cities, and ports.

EPA has implemented a number of grant programs to promote reductions in diesel emissions. Many of these are considered part of EPA's Voluntary Diesel Retrofit Program. For example, EPA funds and administers the Clean School Bus USA program, which seeks to reduce children's exposure to air pollution from diesel school buses through anti-idling strategies, engine retrofits and use of clean fuels, and replacement of pre-1990 buses. In the first two years of the program (2003 – 2004), EPA provided approximately \$10 million in school bus retrofit and replacement grants. The Clean School Bus USA program may be a model for programs focused on other sectors, such as ports and construction. Another program, the West Coast Collaborative, is organized by EPA regional offices to bring attention to the need for additional funding for diesel emission reduction on the West Coast, encourage voluntary projects that reduce diesel emissions, and provide grants. EPA administers several other grant programs aimed at diesel emission reductions, including:

- Diesel Retrofits to Benefit Sensitive Populations, which has provided \$1.6 million in grants via a competitive process

- Diesel Retrofit Grants, which have been used to help local agencies implement diesel emission reduction projects in Oregon and Tennessee
- Regional grant programs, such as Region 10 Regional Geographic Initiative grants
- SmartWay program grants to reduce truck idling

California's Carl Moyer Program is the first successful statewide program providing grants to promote diesel emission reductions. The program began in 1998 and has since provided more than \$150 million in awards to private and public sector applicants. Funding is allocated annually by the California legislature from the state's general fund and requires a local match. Program funding is expected to significantly increase in 2005, up to \$140 million annually. The Moyer Program has historically focused on NOx reductions, although changes enacted in 2004 will allow consideration of projects that reduce exclusively PM or hydrocarbon emissions.

The Moyer Program can be used to fund replacement, repowering, or retrofits for virtually all types of diesel vehicles and equipment. Replacement projects must replace an old engine/vehicle with a newer one certified by the California Air Resources Board (CARB) to more stringent standards; retrofit and repower projects must use equipment certified by CARB to reduce NOx emissions by at least 15 percent with no increase in other emissions. Individual air quality districts in California establish criteria for selecting projects for award; most use emission reduction cost-effectiveness as the primary criterion. In its first four years of operation, Moyer Program projects are estimated to have reduced NOx emissions by more than 5,100 tons per year (14 tons per day) at an average cost-effectiveness of approximately \$3,000 per ton. Approximately 45 percent of Moyer Program funds have gone to on-road sources (trucks), 25 percent to agricultural pumps, 19 percent to marine vessels, and 5 percent to construction equipment.

The Moyer Program is widely recognized as a success by air quality agencies, ports, and construction industry stakeholders. Air quality management districts in California have been able to use the program to achieve substantial reductions in NOx and PM emissions, thereby gaining State Implementation Plan (SIP) credits. Industry stakeholders generally value the program's flexibility and emphasis on cost-effective emission reductions, rather than promoting a particular emission reduction technology or targeting a particular industry sector. Some industry stakeholders have identified opportunities to improve the program. For example, some construction companies report difficulty complying with the requirement that 75 percent of equipment usage occur within the boundaries of the air district providing the funding. Some have also noted that when districts apply caps on awards, it can have the effect of introducing project selection bias against certain cost-effective applications. The complexity and length of the application process can also discourage some equipment owners from applying, particularly small businesses.

The Texas Emissions Reduction Plan (TERP) is the nation's other large grant program focused on diesel emission reductions. Originally modeled after the Moyer Program, TERP has awarded more than \$120 million in grants for diesel retrofits, repowers, and equipment replacement since 2001. Funding for TERP comes from a variety of tax surcharges and inspection fees, including a surcharge on the sale or rental of diesel equipment (both off-road and on-road), a surcharge on truck registration fees and on truck inspections, and a surcharge on vehicle titling fees. Like the Moyer Program, TERP grants are awarded on a competitive basis according to NOx emission reduction cost-effectiveness. TERP also has a separate small grant program dedicated to small businesses.

In the first three years of the TERP program, approximately 280 projects have been selected to receive funding. Projects involving solely off-road equipment (primarily construction equipment) have been awarded 33 percent of funds; another 33 percent of awarded funding has gone to projects involving on-

road equipment. Twenty-nine percent of awards have gone to locomotive projects. The cost-effectiveness of these projects has averaged about \$5,700 per ton of NO_x emission reductions.

Regional and local agencies also implement grant programs to reduce diesel emissions. Funding for these programs typically comes from a combination of federal and state sources, sometimes with additional local contributions. The Diesel Solutions Program in the Seattle region has promoted diesel retrofits on primarily public agency buses and waste hauling vehicles, and also helped to secure the availability of ultra-low sulfur diesel. The Sacramento Emergency Clean Air & Transportation (SECAT) program has awarded more than \$35 million to date for on-road diesel vehicle repowering and truck fleet modernization. In the Long Beach area, the Gateway Cities Clean Air Program has provided \$16 million to date to scrap and replace older trucks in the communities surrounding the Ports of Los Angeles and Long Beach.

The Ports of Oakland, Los Angeles, and Long Beach administer significant grant programs that encourage retrofits, repowering, and replacement of diesel-powered marine terminal equipment. Some of these programs also provide grants to scrap and replace older on-road trucks serving the port. These port-administered grant programs have received significant funding from the ports themselves, sometimes as a result of lawsuit settlement agreements.

Based on the interviews conducted for this study, monetary grants appear to be the most favored incentive among equipment owners and air quality agencies. The technological options for reducing off-road emissions require investment, and while some result in lower operating costs, they do not pay for themselves in operating cost savings. Marine shipping and construction are both highly competitive industries, and very few entities are willing to shoulder voluntarily the additional expense of emission reduction technologies without some compensation. Most grant programs provide equipment owners with the flexibility they need to make their own decisions about how to reduce emissions in a cost-effective, practical manner. Grants can be structured to target emission reductions where they are needed most. The two major statewide grant programs (Carl Moyer and TERP) have been highly successful at achieving off-road diesel emission reductions.

Grant programs require substantial amounts of dedicated funding, which clearly limits the ability of some agencies to offer grants. Grant programs also typically require considerable government time and resources to administer. A complex and lengthy applications process can discourage some applicants, particularly small businesses. Some stakeholders have suggested that grant programs should be structured so the funds are offered as pre-approved rebates to equipment owners that undertake approved emission reduction projects. This approach could reduce the administrative burden associated with a grant program and offer more certainty to applicants.

Tax Incentives

Tax incentives can take the form of tax exemptions, tax deductions (including accelerated depreciation), or tax credits. Some states have enacted tax incentives intended to spur the retrofit or repowering of diesel engines (both on-road and off-road), or to promote use of alternative fuels. Oregon offers an income tax credit of up to 35 percent of the cost of purchasing and installing pollution reduction equipment, including any on EPA's Verified Technology List. Georgia offers an income-tax credit of 10 percent of the cost (up to \$2,500) of diesel particulate emission reduction equipment at truck stops, depots, or other facilities. Neither program has generated any business interest to date, in part because the incentives are perceived as too small.

Port terminal operators have expressed a strong interest in tax incentives. In addition, the Associated General Contractors of America (AGC) has proposed a federal tax deduction to allow firms to write-off

immediately or expense the cost of purchasing and installing diesel retrofit equipment. Under current federal law, firms depreciate the cost of this type of equipment over several years. AGC prefers a tax deduction to a tax credit, because a tax deduction reduces taxable income and, therefore, does not discriminate among different firm ownership structures, which are subject to different income tax rates.

Tax incentives have some advantages relative to grants. They are available all the time, and because they have no application deadline, they can be synchronized with a company's business cycle. Tax incentives are not subject to exhaustion of funds like grants. But the tax incentives currently in place are not as effective as they could be, because they are not large enough to cover the incremental cost of emission reduction technology. In addition, tax incentives may not be useful to companies that make little profit and thus have little tax liability. It can be difficult to use tax incentives to target a particular location or source where emission reductions are most needed. One simple way for states to encourage diesel emission reductions through taxes is to make it easier for off-road equipment owners who voluntarily use on-road diesel (which has lower sulfur content) to receive a refund of the on-road highway user tax.

Modified Contracting Procedures

Contracting provides an enforceable mechanism for state and local governments to reduce diesel emissions on public works projects or, alternatively, provide grants through the contracting process. Four types of modified contracting procedures are:

- Contract specifications
- Contract preferences
- Contract allowances
- Port lease specifications

Contract specifications stipulate emission reduction technology as part of a contract's terms and conditions. Although the Clean Air Act generally prohibits state and local governments from setting their own emission standards for either new or in-use engines, some state and local governments have added provisions to their construction contracts requiring the use of cleaner equipment or the retrofitting or repowering of older equipment. This mechanism appears to be growing in popularity following high profile examples that require retrofits of construction equipment: Massachusetts' Big Dig and Connecticut's Q Bridge I-95 program. These two programs are considered successful and have resulted in the retrofit of more than 160 pieces of equipment. The nation's most extensive effort to use contract specifications for diesel retrofits is occurring in New York City, where Local Law No. 77 will soon require use of ultra-low sulfur diesel fuel and "best available technology" for emissions control for use in all diesel-powered off-road equipment used in city construction projects. Contract specifications are strongly supported by environmental groups.

The proliferation of contract specifications is a major concern to the construction community for several reasons. Generally speaking, contract specifications will increase the cost of public works projects as contractors incorporate the cost of cleaner technologies into their project bids. In a competitive bidding environment, however, companies that have already retrofitted their equipment will hold a competitive advantage for future projects because they will not need to factor-in the cost of retrofit. Similarly, small construction companies may not have the ability to finance the equipment upgrades necessary to win work under a contract specification that is part of a fixed price contract. If implemented widely in a particular region, contract specifications could shrink the market for a construction company with a fleet of older diesel equipment, which would devalue the company's assets. Therefore, construction companies

have also voiced concern that contract specifications might adversely affect a company's financial statement, limiting its ability to borrow money and secure bonding for future projects.

Contract preferences would establish bid evaluation criteria that favor bidders that commit to using emission reduction strategies in performing the work, but would not explicitly require these strategies, much like the preferences sometimes given to small or minority-owned businesses. We were unable to identify any examples of contract preferences being used to encourage diesel emission reductions. This mechanism appears to be inferior as compared to other forms of modified contracting procedures, because it introduces too much uncertainty for both contractors and public agencies.

Contract allowances incorporate a payment to the contractor to offset, fully or partially, the cost of emission reduction investments. A contract allowance can be structured like a contract specification paired with a grant to the winning bidder (e.g., the emission reductions are required), or can merely provide optional incentives to encourage the contractor to invest in emission reduction technologies. When paired with contract specifications, contract allowances may provide a mechanism to help level the playing field for small contractors who cannot finance investments in emission reduction technologies. Although contract allowances are reportedly under consideration in several places, the City of Atlanta and the Texas Department of Transportation appear to be the only government agencies that have actually tried this mechanism. These programs have just been implemented, and it is too soon to assess their success.

Similar to contract specifications, port authorities can specify emission reduction technologies or operations in their lease agreement with marine terminal operators. The only example to date of a *port lease specification* that stipulates diesel emission reductions is at the Port of Los Angeles, where the Port is requiring measures such as vessel electrification (cold ironing), retrofits on yard tractors, and use of emulsified fuel in cargo handling equipment. This mechanism appears unlikely to spread widely outside Southern California in the near term because most ports are hesitant to stipulate diesel emission reductions in a lease for fear it would harm their competitive position. The effectiveness of lease specifications in achieving port-wide emission reductions is hindered by the long leases at many terminals and, thus, infrequent opportunities to negotiate new lease terms.

Environmental Stewardship and Non-Monetary Incentives

Some non-monetary incentives can encourage owners of off-road diesel equipment to reduce emissions in the name of *environmental stewardship* or *improving operational efficiency*. Adoption of an environmental management system (EMS), for example, provides a framework to integrate environmental decision-making into an organization's day-to-day operations, making it easier to find and fix the root causes of potential environmental problems. While development and implementation of an EMS entails some upfront costs, organizations with an EMS benefit on many fronts, including improved community relations and public image, better internal communication, and long-term cost savings. Improving the operational efficiency of ports and construction activities often results in lower fuel use and emissions. Government agencies and ports can encourage environmental stewardship by providing public recognition, educational information about opportunities to reduce emissions or improve efficiency, and guidance on voluntary actions to assess current emissions and plan for improvements; they can also act as a facilitator to create opportunities for information exchange and leverage additional funding.

Other Types of Incentives

Other types of incentives include:

- State Implementation Plan (SIP) credits

- Mobile source emission reduction credits
- General conformity credits
- Supplemental Environmental Projects
- The Coast Guard's Qualship 21 program
- Differentiated port fees
- Building permit fee rebates

SIP credits are one of the primary factors motivating state and regional air quality agencies to seek diesel emission reductions. Voluntary industry actions to reduce diesel emissions may be well suited to SIP credit as a Voluntary Mobile Source Emission Reduction Program (VMEP). *Mobile source emission reduction credits* (MERCs) appear to have potential for greater use in the off-road diesel sector but to date have proven impractical because of the high certification costs. *General conformity credits* could provide an incentive for ports to take early action to reduce diesel emissions by ensuring that the port can later use the emission reductions to satisfy general conformity requirements during construction. For companies that have violated federal environmental laws, *Supplemental Environmental Projects* offer an incentive to reduce emissions beyond legally mandated compliance actions, with the benefits going to the community affected by the violation. The *Coast Guard's Qualship 21 program* might be a mechanism to provide incentives for vessels to comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI emission standards. *Differentiated port fees* could be used to promote low sulfur bunker fuels or other emission reduction technologies on ships, as currently occurs in several European nations. This incentive is one of the few opportunities to influence emissions from oceangoing marine vessels, most of which are not U.S.-owned. Finally, *building permit fee rebates* could be offered by local governments as an incentive for construction companies to reduce diesel emissions during building construction projects.

Clearly, no single type of incentive offers the solution to the off-road diesel emissions problem. An effective approach to curbing emissions from in-use construction equipment, marine terminal equipment, and ships will depend on a combination of incentives, including grants, tax incentives, contracting procedures, and non-monetary incentives. A number of potential incentive programs may, in fact, work best when paired with other types of incentives. For example, a tax incentive or contract allowance paired with a contract specification could provide both a "carrot" and a "stick" to the construction industry in a particular region. Grant programs could be more effective when coupled with non-monetary incentives that encourage environmental stewardship. And a building permit fee rebate program would work best if offered in conjunction with public recognition for participants.

1 INTRODUCTION

Diesel engines power much of the world's off-road vehicles, equipment, and vessels. The power, durability, and efficiency of the diesel engine make it suitable for use in a wide range of applications in construction and at ports. Diesel engines are also a major source of air pollution, particularly emissions of nitrogen oxides (NOx), particulate matter (PM), sulfur oxide gases (SOx), and toxic air pollutants, all of which contribute to serious adverse health and environmental effects. The U.S. Environmental Protection Agency (EPA) is taking steps to reduce emissions from new diesel engines in off-road use by adopting emission standards for most off-road diesel equipment, railroad locomotives, and marine vessels, as well as adopting fuel standards. The emission standards cover only new engines, however, and will not come into full effect for at least a decade. There is an urgent need to reduce emissions from the existing off-road diesel fleet.

1.1 Overview

This report describes and assesses incentives that government agencies and other organizations can provide to encourage the reduction of emissions from diesel engines. The report focuses on two industry sectors that rely heavily on diesel engines: the construction industry and the port sector. The incentives reviewed in this report fall into several categories: grant programs, tax incentives, modified contracting procedures, non-monetary incentives that promote environmental stewardship, and others. We describe a variety of incentive programs currently used by federal, state, regional, and local government agencies. We assess what has made these programs successful or unsuccessful, and identify opportunities for improvement.

While it is recognized that regulations and other mandates are a critical part of an overall strategy to reduce diesel emissions, the scope of this report is primarily limited to potential non-regulatory incentives for reducing emissions from off-road diesel engines in the port and construction sectors. The report summarizes relevant regulations and other mandates in order to provide context for examining voluntary incentives that port and construction sector stakeholders might find appealing. It is also recognized that regulations and lawsuits (or the potential for them) have provided an impetus for the establishment of and participation in a number of the incentive programs discussed in this report.

This report was prepared for EPA's Sector Strategies Program, which works with specific industry sectors (including ports and construction) to address the most significant impediments to better environmental performance in each sector. One of the three priority areas of the Sector Strategies Program is overcoming regulatory or other barriers to performance improvement. This report is intended to help the port and construction sectors overcome regulatory, economic, and other barriers that impede the adoption of cleaner off-road diesel technologies.

Off-Road vs. Non-Road

The terms "off-road" and "non-road" are often used interchangeably by government agencies and equipment owners. EPA uses the term "non-road" to cover a diverse collection of mobile (non-stationary) engines, equipment, vessels, and vehicles that do not travel on public roadways. The California Air Resources Board and other state air quality agencies typically refer to these sources as "off-road." The off-road/non-road category includes outdoor power equipment, recreational vehicles, farm and construction machinery, lawn and garden equipment, marine vessels, port cargo handling equipment, locomotives, and many other applications. In this report, we generally use the term "off-road," although we use EPA terminology when referring to specific EPA programs.

This report will also inform the efforts of the Clean Diesel and Retrofit Workgroup, which is a part of the Mobile Sources Technical Review Subcommittee of the Clean Air Act Advisory Committee, a federal advisory committee that provides advice to EPA on air pollution issues. The Retrofit Workgroup is developing recommendations on incentives that could be pursued at the federal level to expand EPA's current voluntary diesel reduction programs to include other industry sectors. The Workgroup has identified the port and construction sectors as good candidates for participation in EPA's voluntary programs.

1.2 Research Approach

For this report we reviewed incentive program information from public agencies, interviewed public and private sector stakeholders, and reviewed other related literature. We first performed a literature review to identify existing incentive programs and appropriate stakeholder contacts. This included a review of program information produced by EPA, the California Air Resources Board (CARB), the Texas Commission on Environmental Quality (TCEQ), as well as various regional air quality agencies. We also reviewed the list of state and federal incentives and laws related to alternative fuels provided by the U.S. Department of Energy's Clean Cities Program¹ and Database of State Incentives for Renewable Energy (DSIRE) operated in conjunction with North Carolina State University.²

We reviewed recent reports that provide background on equipment, emission reduction strategies, and incentives. Four particularly helpful reports were:

- Diesel Technology Forum, *Diesel-Powered Equipment: Essential Uses, Economic Importance and Environmental Performance*, 2003.
- Diesel Technology Forum, *Cleaner Air, Better Performance: Strategies for Upgrading and Modernizing Diesel Engines*, May 2003.
- Natural Resources Defense Council, *Harboring Pollution: Strategies to Clean Up U.S. Ports*, August 2004.
- BMT Fleet Technology Limited, *Management Options for Marine Vessel Emissions*, Prepared for Environment Canada, Pacific and Yukon Region, June 2004.

We conducted initial interviews with staff at the two major industry groups representing the construction and port sectors – the Associated General Contractors of America (AGC) and the American Association of Port Authorities (AAPA). The purpose of these interviews was to help identify incentive options that warranted further research, to identify potential stakeholder contacts, and to gain a better understanding of the positions of the construction industry and port authorities regarding diesel emission reduction incentives. Additional stakeholder contacts were identified by staff in EPA's Sector Strategies Program.

We then conducted a series of interviews with stakeholders in the construction and port sectors, state and local agencies, and environmental organizations to discuss the pros and cons of specific incentive programs and to discuss options for new programs. Industry opinions were sought in particular because of EPA's intention to develop incentives that will appeal to port terminal operators and construction contractors. The interviews did not follow a script (i.e., there was no pre-set list of questions) but rather were discussions tailored to the position of and programs available to each interviewee. Most interviews covered the full range of possible incentive options, while others focused on one or two specific programs or issues. Interviewees included port authorities, port terminal operators, construction companies and

¹ See http://www.eere.energy.gov/cleancities/incen_laws.html

² See <http://www.ies.ncsu.edu/dsire/>

related trade groups, state and local agencies, environmental and public health advocacy organizations, and EPA headquarters and regional staff.

We assessed the incentive program options based on a number of factors, including the potential for emission reduction, the ease of start-up and implementation, transferability, ease of participation (for recipients), and effects on competition (e.g., small businesses).

1.3 Report Organization

The remainder of this report is organized into seven sections. Section 2 presents background on diesel equipment used in the construction and port sectors, strategies for reducing emissions, emission standards relevant to off-road sources, and current EPA efforts to address emissions from in-use diesel engines. Sections 3 – 7 are organized by incentive program type, as follows:

- Section 3 discusses grant programs, including those administered by EPA, states, regional agencies, and ports.
- Section 4 discusses tax incentives that can promote diesel emission reductions.
- Section 5 discusses the use of modified procedures for construction contracting and port terminal leases as a mechanism to promote off-road diesel emission reductions.
- Section 6 discusses voluntary actions that ports and construction companies can take to reduce emissions to achieve environmental stewardship objectives.
- Section 7 reviews a variety of other types of incentive programs to reduce off-road diesel emissions, including State Implementation Plan (SIP) credits, mobile source emission reduction credits, general conformity credits, Supplemental Environmental Projects, the Coast Guard's Qualship 21 program, differentiated port fees, and building permit fee rebates.

Section 8 summarizes the report findings.

2 BACKGROUND

This section describes:

- Off-road diesel equipment used in the port and construction sectors, pollutant emissions caused by that equipment, and related health effects
- EPA emission standards for off-road construction and port cargo handling equipment, marine vessels, and locomotives
- Technological and operational strategies for reducing emissions from diesel engines used at ports and in construction activities
- Current EPA efforts to address emissions from in-use diesel engines, including voluntary programs and verification of emission reducing technologies
- Other state and local government regulations that affect off-road diesel emissions

2.1 Off-Road Diesel Equipment and Emissions

According to EPA, there are currently about six million pieces of off-road diesel equipment in use in the U.S., and over 650,000 pieces of off-road diesel equipment are sold in the U.S. each year.³ This equipment is used in such industries as construction, ports, airports, agriculture, and mining. This report focuses primarily on incentives that could apply to off-road equipment used in the construction industry and at ports.

Overview of Port Equipment

There are approximately 80 public port authorities in the U.S., developing and managing ports located along the Atlantic, Pacific, Gulf, and Great Lakes coasts. These ports provide more than 3,000 berths for deep draft ships, moving cargo and passengers through 2,000 marine terminals.⁴ Ports handle 95 percent of the nation's international trade by weight and 75 percent by value.⁵ Commercial port activities provide employment for more than 1.4 million Americans.⁶

Many ports are facing pressure to develop newer, larger, and more efficient facilities to accommodate increased waterborne trade. Container throughput at U.S. ports has grown by 90 percent over the last 10 years, or 6.7 percent annually, and strong growth is expected to continue.⁷ In response to the increase in

Examples of Off-Road Equipment at Ports

Cargo handling equipment	<ul style="list-style-type: none"> • Yard tractors • Top and side loaders • Forklifts • Wharf cranes • Rubber tire gantry cranes • Skid loaders
Harbor vessels	<ul style="list-style-type: none"> • Tugboats and pushboats • Ferries • Excursion vessels • Dredging equipment
Oceangoing vessels	<ul style="list-style-type: none"> • Container ships • Tanker ships • Bulk carrier ships • Cruise ships
Locomotives	<ul style="list-style-type: none"> • Line haul locomotives • Switch yard locomotives

³ U.S. EPA, "Clean Air Nonroad Diesel Rule Summary," EPA 420-F04-029, May 2004.

⁴ U.S. EPA, *Sector Strategies Performance Report*, 2004.

⁵ Data from the American Association of Port Authorities.

⁶ Data from the American Association of Port Authorities.

⁷ Data from the American Association of Port Authorities.

trade, ports are spending heavily on capital improvements. In addition, cruise ships and other waterborne passenger services are increasingly using commercial port facilities, adding to pressure for expansion.⁸

Port authorities are typically created by state governments. Many port authorities serve as “landlords,” meaning they do not own cargo handling equipment or operate marine terminals. Landlord ports lease their space to shipping lines or terminal operating companies. Some port authorities directly operate one or more of their terminals and own cargo handling equipment. Port authorities also may oversee operation of other transportation facilities, including airports, bridges, and railroads, as well as considerable construction activity at these facilities.

At ports, off-road equipment can include on-dock cargo handling equipment, harbor vessels, oceangoing vessels, and railroad locomotives (see box on previous page). On-dock equipment is used to unload and load ship cargo, move cargo to and from docks and intermodal (IM) facilities, and rearrange containers on site and in storage areas. Harbor vessels are operated within the port vicinity, while oceangoing vessels carry freight and passengers between ports. At ports that are served directly by a rail line, locomotives operate in the port area. Ports are also the focus for large amounts of on-road truck activity – primarily vehicles transporting shipping containers to and from the port.

Overview of Construction Equipment

Construction in the U.S. is an \$850 billion industry, employing more than 6 million people in 700,000 companies.⁹ The sector includes building construction, highway construction, heavy industrial construction (e.g., tunnels, airports, and dams), municipal utility construction (e.g., wastewater treatment plants), and special trades such as plumbing, heating, and demolition contractors. Most construction companies are small businesses. Off-road engines used by construction companies are found in a wide variety of loaders, dozers, excavators, graders, and other specialized equipment (see box to right).

Diesel Engines and Emissions

The vast majority of off-road equipment used in construction and at ports is powered by diesel engines.

Diesel engines are “compression ignition” engines, meaning that the fuel-air mixture in the engine cylinders ignites automatically when compressed, as opposed to gasoline-powered engines that rely on a spark to ignite the fuel. Diesel engines offer a number of advantages over spark-ignition engines:¹⁰

- More power – Diesel engines can produce more power at the low engine speeds that are common in many off-road applications.
- Durability – Diesel engines are able to withstand long periods of intensive use.

Examples of Off-Road Equipment Used in Construction

Loaders	<ul style="list-style-type: none"> • Wheel loaders • Skid steer loaders
Dozers	<ul style="list-style-type: none"> • Wheel dozers • Landfill compactors
Excavation	<ul style="list-style-type: none"> • Excavators • Backhoes
Road construction	<ul style="list-style-type: none"> • Asphalt pavers • Motor graders • Asphalt compacters
Other applications	<ul style="list-style-type: none"> • Borers/drill rigs • Off-highway trucks • Scrapers

⁸ U.S. EPA, *Sector Strategies Performance Report*, 2004.

⁹ U.S. Census Bureau, as cited in U.S. EPA, *Sector Strategies Performance Report*, 2004.

¹⁰ Diesel Technology Forum, *Diesel-Powered Equipment: Essential Uses, Economic Importance and Environmental Performance*, 2003.

- Large size – Diesel engines can be built for very large applications like ships and locomotives. Spark-ignition engines are typically limited to a maximum of 10 liters in displacement (usually less than 6 liters) and 400 horsepower.
- Efficiency – Diesel engines achieve greater fuel efficiency than spark-ignition engines.

Diesel engines are also a major source of air pollution, particularly emissions of NO_x and PM. Diesel fuel contains sulfur that contributes to particulate and SO_x emissions. Because the compression pressure in diesel engines is higher than in spark-ignition engines, the temperatures within the combustion chamber are higher and result in much higher NO_x emissions. In addition, diesel fuel contains more complex molecules than gasoline, and when burned, results in relatively high particulate emissions, particularly under heavy load when the air/fuel mixture is richer. Large marine engines burn residual (or “bunker”) fuel, a more viscous form of diesel that results in even higher particulate matter emissions. Diesel engines typically run fuel-lean (excess air) most of the time, so the typical three-way catalyst systems used on gasoline engines cannot be used on diesel engines, although there are some technologies that are effective at reducing diesel emissions.

According to EPA’s 2001 National Emission Inventory, non-road diesel engines (including construction and agricultural equipment, marine vessels, and locomotives) are responsible for 16 percent of NO_x emissions nationally (3,600 tons per year) and 29 percent of NO_x emissions from mobile sources. These percentages can be considerably higher in some urban areas.

Nationally, PM emissions are dominated by fugitive dust sources (mostly from farming and unpaved roads), which are less dangerous to human health than the smaller particulates produced by fuel combustion. Excluding these miscellaneous area sources, non-road diesel engines are responsible for eight percent of fine particulate emissions (PM-2.5) nationally (222 tons per year) and half of PM-2.5 emissions from mobile sources. Again, these percentages can be considerably higher in some urban areas.

2.2 Health and Air Quality Effects

Health and Environmental Effects of Diesel Emissions

NO_x, SO_x, PM, and toxic air pollutant emissions contribute to serious adverse health effects and environmental effects.¹¹ NO_x reacts with volatile organic compounds (VOC) to form ground-level ozone, commonly known as smog. Ground-level ozone can trigger a variety of health problems including aggravated asthma, reduced lung capacity, and increased susceptibility to respiratory illnesses like pneumonia and bronchitis. People with respiratory problems are most vulnerable, but even healthy people who are active outdoors, such as construction and port workers, can be affected when ozone levels are high. Ozone also contributes to crop damage, ecosystem damage, and other effects. NO_x can also form particulate nitrate, especially in western areas of the country.

Many scientific studies have linked breathing PM to a series of significant health problems, including aggravated asthma, difficult breathing, chronic bronchitis, myocardial infarction (heart attacks), and premature death. Increases in particulate matter levels are associated with increased hospital admissions and emergency room visits for people with heart and lung disease, and increased work and school absenteeism. Diesel exhaust is of specific concern, because it is likely to be carcinogenic to humans by inhalation and pose a hazard from non-cancer respiratory effects. In addition to EPA, a number of other agencies (National Institute for Occupational Safety and Health, the International Agency for Research on

¹¹ For a summary of health effects and references to numerous scientific studies, see Natural Resources Defense Council, *Harboring Pollution: Strategies to Clean Up U.S. Ports*, August 2004.

Cancer, the World Health Organization, California EPA, and the U.S. Department of Health and Human Services) have identified the serious health effects of diesel exhaust. PM is also the major source of haze that reduces visibility, and can cause erosion structures such as monuments and statues.

Air Quality

As required under the Clean Air Act, EPA sets National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. These pollutants include ozone and particulate matter. The primary air quality standards set limits to protect public health, including the health of “sensitive” populations such as asthmatics, children, and the elderly. EPA designates an area as “nonattainment” if it has violated (or contributed to a violation of) the NAAQS.

In April 2004, EPA designated nonattainment areas throughout the country that exceed the health-based standards for 8-hour ozone.¹² These areas include part or all of 474 counties nationwide, home to 159 million people. In December 2004, EPA designated nonattainment areas that exceed the fine particulate (PM-2.5) standards.¹³ These areas include all or part of 200 counties nationwide.

By law, nonattainment areas are subject to certain requirements to reduce pollution, including adoption of a State Implementation Plan (SIP) that describes an approach for the region to attain the NAAQS. Many of these nonattainment areas are struggling to identify measures to reduce NOx and PM emissions as part of the SIP process. There is also a need to reduce particulate emissions near “hotspots,” including locations near ports, truck terminals, major highways, and construction sites where residents and workers are exposed to high concentrations of diesel exhaust.

2.3 EPA Emission and Fuel Standards

Recognizing the health effects of diesel emissions and the challenges associated with meeting the NAAQS, EPA is taking steps to ensure that off-road diesel engines in the future produce far fewer pollutant emissions. This section reviews EPA emission standards that apply to diesel construction equipment and off-road port cargo handling equipment, marine vessels, and locomotives.

EPA regulates emissions from new non-road diesel engines, except in California, where the California Air Resources Board (CARB) has authority to set most emission standards. California standards are generally identical or very similar to EPA standards. EPA also sets standards for fuel composition. EPA standards for non-road engines have historically lagged behind on-road emission standards.¹⁴ For example, while heavy-duty diesel trucks have been regulated since the 1980s, most construction and port cargo handling equipment was unregulated until 1999, locomotives were unregulated until 2000, and commercial marine vessels were unregulated until 2004. EPA is now working to phase in new emission standards for these sources. These standards will closely track the most stringent emission requirements for on-road trucks that begin in 2007. The standards follow a “systems” approach by regulating fuel sulfur levels in addition to engine exhaust emissions, thereby facilitating the use of advanced exhaust after-treatment technology. Note, however, that most EPA standards apply only to new engines and equipment at the time of manufacture, and do not affect existing equipment.

¹² For more information, see <http://www.epa.gov/ozonedesignations/>

¹³ For more information, see <http://epa.gov/pmdesignations/>

¹⁴ For a concise summary of the changes in emissions standards, see Union of Concerned Scientists, *Cleaning Up Diesel Pollution*, June 2003.

EPA Non-Road Emission Standards

EPA has regulated emissions from non-road engines used in most construction and port cargo handling equipment since 1999. These regulations continue to be phased in under a four-tier system, with emission standards based on engine horsepower (hp) and equipment model year. Table 2-1 shows these standards for engines between 25 and 750 horsepower in units of grams per horsepower-hour (g/hp-hr); additional standards apply to smaller and larger engines (see Appendix A for a complete listing of EPA emissions standards).

Tier 1, 2, and 3 standards are largely being met by enhanced engine design and manufacturing improvements; they require little or no exhaust after-treatment, and do not address fuels. The Tier 4 standards require dramatic reductions in NO_x and PM emissions, akin to the emission reductions required by 2007 standards for on-road heavy-duty diesel trucks. The non-road NO_x and PM standards under Tier 4 are approximately 10 times lower than the Tier 3 standards for most engines. They will be phased in between 2008 and 2015.

To comply with this rule, engine manufacturers will need to produce engines with advanced emission control technologies similar to those that will be used for on-road trucks. This ruling also requires fuel producers to reduce the sulfur

content of diesel fuel used in non-road engines (see description on following page). Reducing the level of sulfur in diesel fuel is necessary to prevent damage to the emission control systems.

EPA Marine Vessel Emission Standards

For regulatory purposes, commercial marine engines are classified as Category 1, 2, or 3, based on size. EPA established the first emission standards for these engines in 2000 to take effect between 2004 and 2007. The standards require relatively modest reductions in NO_x, CO, and PM (see Appendix A). In May 2004, EPA announced its intent to propose more stringent emission standards for all new commercial, recreational, and auxiliary marine diesel engines, except Category 3 engines. The new emission standards are expected to be modeled after the 2007/2010 highway and Tier 4 non-road diesel engine programs, with an emphasis on achieving large reductions in emissions of PM and air toxics through the use of advanced emission control technology. It is important to note that EPA standards apply only to U.S. flagged vessels. While the vast majority of Category 1 and 2 engines in U.S. waters are U.S. flagged, most Category 3 vessels are foreign flagged and thus, not subject to EPA regulations.

The International Maritime Organization (IMO) leads the development of international regulations for ships. The IMO adopted Annex VI of the International Convention on the Prevention of Pollution from Ships (MARPOL) in 1997 to set NO_x emissions standards for ships. MARPOL Annex VI will come into force in May 2005, and at that time, any country that has ratified the treaty can enforce the NO_x emission standards for any ships in its waters. It applies to engines on ships constructed on or after January 1, 2000. The U.S. Senate has not ratified MARPOL Annex VI. If the U.S. Senate ratifies MARPOL Annex VI, then it can be enforced against any foreign flag ship that visits a U.S. port, whether or not the flag state of the ship has ratified the treaty. Until Annex VI is ratified, however, only a small fraction of Category 3 marine engines in U.S. waters are subject to emission regulations.

Table 2-1: EPA Non-Road Emission Standards (25 – 750 hp engines)

	First Model Year	Emission Standard (g/hp-hr)	
		NO _x +NMHC	PM
Tier 1	1999	7.1	0.60
Tier 2	2001 – 2006	4.8 - 5.6	0.15 - 0.45
Tier 3	2006 – 2008	3.0 - 3.5	0.15 - 0.45
Tier 4	2011 – 2013	0.3 - 3.5	0.01 - 0.02

Notes: Standards and model year vary with horsepower; NMHC stands for non-methane hydrocarbons; the 0.3 Tier 4 standard is for NO_x only.

EPA Locomotive Emission Standards

In April 1998, EPA finalized emission standards for locomotives, which took effect in 2000 and involve a three-tiered system (see Appendix A). EPA has announced its intent to propose more stringent emission standards for new locomotive diesel engines. Like the new standards planned for marine vessels, the new locomotive emission standards are expected to be modeled after the 2007/2010 highway and Tier 4 non-road diesel engine programs, with an emphasis on achieving large reductions in emissions of PM and air toxics through the use of advanced emission control technology.

EPA Standards for Sulfur Levels in Diesel Fuel

Sulfur in diesel fuel prevents the use of advanced emission control equipment and is also a source of sulfate particulate emissions. Diesel fuel for off-road engines currently contains about 3,000 parts per million (ppm) sulfur. Starting in 2007, EPA's 2004 Clean Air Non-Road Diesel Rule sets a 500 ppm limit for sulfur in diesel fuel produced for non-road engines, locomotives, and marine applications (not including engines on oceangoing vessels). The rule sets a subsequent limit of 15 ppm sulfur (ultra-low sulfur diesel) for non-road fuel by 2010 and by 2012 for locomotive and marine applications. EPA has required diesel sold for on-road use meet the ultra-low sulfur standard starting in 2006. In California, CARB regulations require ULSD for both on-road and off-road applications starting in 2006, with the exception of some marine vessels and locomotives.

Nearly all Category 3 marine engines and some Category 2 engines use a form of residual fuel, a more viscous form of diesel. While diesel fuel is a distillate, composed of petroleum fractions of crude oil that are separated in a refinery by a boiling process, residual fuel is the fraction of crude oil that does not boil. Some vessels use a blend of distillate and residual fuel called "intermediate." Sulfur levels in residual fuel are not subject to EPA regulation and are typically 10 times higher than in current off-road diesel fuel (i.e., 30,000 to 50,000 ppm sulfur in residual fuel vs. 3,000 ppm in off-road diesel). Oceangoing vessels calling on U.S. ports often purchase residual fuel in other countries.

2.4 Strategies for Reducing Emissions from In-Use Diesel Engines

The EPA emission standards described above will significantly reduce pollutant emissions from new off-road diesel equipment, particularly when the more stringent standards, which rely on the availability of ULSD, take effect. Nevertheless, emissions from off-road diesel engines will continue to be a major source of air pollution and related health and environmental effects for a number of years because:

1. The most stringent off-road emission standards for new equipment will not fully take effect for at least a decade. The Tier 4 standards for off-road equipment will be phased in between 2008 and 2015. Similar standards for locomotives and marine vessels are expected to be adopted soon, but would not come into effect until after 2010.
2. Off-road diesel equipment lasts a long time. Some types of construction equipment are used for 15 to 20 years. Locomotives and marine vessel engines can last more than 30 years. The stringent EPA emission standards apply only to new diesel engines and equipment at the time of manufacture and do not affect existing equipment. Thus, even after the Tier 4-type standards come into effect, it will take many years before the bulk of the off-road fleet meets these standards.
3. EPA has no authority to regulate foreign-flagged marine vessels. While the ratification of IMO Annex VI would allow the U.S. to enforce the Annex VI NO_x standards for any vessel in U.S. waters, these standards require only modest NO_x emission reductions and do not regulate PM

emissions. Thus, ocean going vessels will continue to be a major source of air pollution in areas with major ports and in other coastal areas near busy ship traffic lanes.

4. The fleet of construction equipment and the associated hours of operation will grow as the U.S. economy expands. At U.S. seaports involved in international trade, freight activity is growing much faster than the U.S. economy. The cruise industry is also expanding rapidly at some ports.

Thus, there is an urgent need to reduce emissions from off-road diesel engines in use today and those that will be manufactured over the next five to eight years. This section briefly reviews the two types of strategies for achieving these reductions:

- Technological strategies that modify the piece of equipment or its fuel to reduce emissions.
- Operational strategies that change the way the equipment is used in a way that reduces emissions.

Technological Strategies

Technological strategies can be summarized as the “Five Rs” – Retrofit, Repower, Refuel, Replace, and Repair/Rebuild.

Diesel Retrofit

A retrofit typically involves the addition of an after-treatment device to remove emissions from the engine exhaust.¹⁵ Retrofits can be very effective at reducing emissions – eliminating up to 90 percent of pollutants in some cases. Many of the effective after-treatment devices require use of ULSD. Some examples of after-treatment devices used for diesel retrofits are summarized in the box to the right.

Developing and commercializing exhaust after-treatment devices for off-road applications presents some unique

Examples of Diesel Retrofit Technologies

Diesel oxidation catalysts use a chemical process to convert PM into less harmful components through oxidation with the excess air inherent in diesel exhaust. They have been used for over 20 years and are perhaps the most proven after-treatment device. Diesel oxidation catalysts can lower emissions of PM by 20 to 30 percent, but do not affect NOx emissions. They work best when used with lower sulfur diesel fuel (less than 350 ppm), but do not require ULSD less than 30 ppm.

Diesel particulate filters collect particulate matter in the exhaust stream. The high temperature of the exhaust heats the filter’s internal structure (typically composed of ceramic) and allows the particles inside to be converted into the less harmful components of carbon dioxide and water vapor. These filters can be installed on both new and used vehicles, but they must be used with ULSD and appropriate duty cycles with sufficiently high exhaust temperatures. Diesel particulate filters can reduce PM emissions by 50 to 90 percent, but do not affect NOx emissions.

NOx catalysts employ a chemical process to lower NOx emissions, although these devices have not been tested extensively in off-road applications. Lean NOx catalysts employ a diesel fuel spray in the exhaust to lower NOx emissions by up to 25 percent. NOx adsorbers can eliminate more than 70 percent of NOx, but require the use of diesel fuel with very low sulfur levels (typically no more than 10 to 15 ppm) and to date are not commercially available even for on-highway applications.

Selective catalytic reduction (SCR) technology is currently employed at many power plants to chemically reduce NOx emissions to nitrogen and water, but has only recently been adapted to vehicles and other mobile sources. SCR requires a reducing agent (ammonia or urea) to be injected into the exhaust stream. SCR has been shown to lower NOx emissions by 75 to 90 percent but has no effect on PM emissions. An SCR system can be used in conjunction with a diesel particulate filter to achieve significant PM and NOx reduction (potentially 80 to 90 percent for both pollutants).

¹⁵ For a detailed description of retrofit technologies, see Northeast States for Coordinated Air Use Management (NESCAUM), *Status Report on Clean Mobile Source Diesel Initiatives in The Northeast States and Eastern Canadian Provinces*, prepare for New England Governors/Eastern Canadian Premiers Conference, September 2003.

challenges.¹⁶ Off-road diesel engines are used in a much wider variety of applications than on-road diesel engines and are subject to diverse operating conditions. Most off-road equipment relies on the engine to both move the vehicle *and* to operate attachments like buckets, blades, and shovels. Off-road equipment is often subject to strenuous duty cycles, alternating frequently between heavy power demand and idling. And unlike on-road engines, the duty cycles for off-road applications vary widely, even for a given engine model.

Developing cost-effective emission control systems for off-road engines is made more difficult by the relatively large number of equipment manufacturers producing for a wide diversity of applications in relatively low production volumes. While advanced emission controls often need to be customized to a specific engine model and application, the engineering and production costs of these technologies for off-road engines are spread over relatively few units. This contrasts with the relatively few models and high volumes of on-road engines sold.

Diesel Repower

Repowering involves replacing an existing engine with a new engine. This strategy is most effective for use in diesel-powered equipment with a useful life longer than that of the engine. Repowering provides an opportunity to install a new engine that meets much lower emission standards than the original engine, often in conjunction with fuel economy benefits and lower maintenance costs. Repowering can also include converting diesel-powered equipment (such as port cranes) to electrical power.

Alternative Fuels

A variety of alternative fuels can be used in diesel engines. Some require little or no modification to the engine (such as emulsified diesel or biodiesel) while others (such as natural gas) require engine conversion or replacement. The alternative

Examples of Alternative Fuels

Emulsified diesel is a blended mixture of diesel fuel, water, and other additives that reduces emissions of PM and NOx. Emulsified diesel can be used in any diesel engine, but the addition of water reduces the energy content of the fuel, so some reduction in power and fuel economy can be expected. Emulsified diesel sold under the name Lubrizol PuriNOxTM has been certified by both EPA and CARB for emission reductions in off-road applications. Expected NOx reductions are in the range of 17 to 20 percent; PM emission reductions range from 17 to 50 percent.

Biodiesel is a renewable fuel that can be manufactured from new and used vegetable oils and animal fats. Biodiesel is safe and biodegradable and reduces emissions of PM, CO, hydrocarbons (HC), and air toxics. However, some studies have demonstrated small NOx emissions increases (up to 10 percent using B100, i.e. “pure” biodiesel). Biodiesel is often used as a blend, typically 80 percent petroleum diesel and 20 percent biodiesel (B20).

Natural gas, in the form of compressed natural gas (CNG) or liquefied natural gas (LNG), can be used to power off-road engines. Existing diesel engines can sometimes be converted to run on natural gas, or the existing engine can be replaced with a natural gas engine. There is often a fuel penalty incurred when migrating from traditional diesel fuel, as well as a power loss (unless the engine is recalibrated), due to lower heating content of natural gas, when compared with diesel fuel. In addition, the use of natural gas raises some challenges with respect to storage and safe handling of the fuel, and the infrastructure (CNG station, transfer lines, etc.) to deliver this fuel to customers.

Propane can also be used to power diesel engines in some applications. Commercial kits are available for retrofitting diesel engines to operate on liquid propane gas (LPG). A number of diesel yard tractors at southern California ports were recently converted to LPG. Compared to unregulated (Tier 0) yard tractors, LPG can significantly reduce NOx and PM emissions, although can increase HC emissions.

Ethanol can be blended with diesel to reduce some emissions. Sometimes known as “E-diesel” or “oxydiesel”, these blends typically have 10 percent ethanol. Ethanol-diesel blends have not been widely used.

¹⁶ Diesel Technology Forum, *Diesel-Powered Equipment: Essential Uses, Economic Importance and Environmental Performance*, 2003.

fuels summarized in the box to the right can reduce emissions from off-road diesel equipment, although many come at a price of lower fuel efficiency or power.

In addition to these fuels, use of diesel fuel with lower sulfur content can help to reduce emissions. As described in Section 2.2, ULSD has less than 15 ppm sulfur, compared to 500 ppm typically used in today's on-road diesel and 3,000 ppm in today's off-road diesel. The primary purpose of ULSD is to enable or improve the performance of after-treatment technologies, such as a particulate filter. Using on-road diesel or ULSD in off-road applications can improve the performance of diesel oxidation catalysts. Use of ULSD alone (without after-treatment) in many off-road applications can reduce PM emissions by five to fifteen percent compared to higher sulfur diesel. Use of marine fuel with sulfur content of 15,000 ppm instead of 27,000 ppm (the global average) would reduce PM emissions by 18 percent.¹⁷ The Port of Los Angeles has signed agreements with many shipping lines to promote the use of lower-sulfur marine fuels.

Hybrid-electric power may soon offer fuel savings and emission reductions in a number of off-road applications. For example, many freight railroads are currently experimenting with hybrid switcher locomotives, such as the "Green Goat." The Green Goat relies on battery power to run electric traction motors on the axles. The lead acid batteries are charged by a small onboard diesel-powered generator and microturbine. The reduced reliance on diesel fuel allows for a 30 percent reduction in fuel use and up to a 90 reduction in NOx emissions, compared to a conventional switcher locomotive.

Replacement

Selectively replacing older diesel equipment can sometimes be the most cost-effective way to reduce the emissions of a fleet. In this way, older, higher polluting equipment is retired from service before it would otherwise be retired. Newer equipment that meets more stringent emission standards is purchased to replace the retired equipment, sometimes in conjunction with retrofit devices or alternative fuels. These programs are sometimes called "scrappage" or "fleet renewal" programs. Such programs often include procedures to ensure that the retired equipment is destroyed in order to prevent re-sale and continued use. Fleet owners often benefit from improved fuel economy and performance, as well as lower maintenance costs.

Repair/Rebuild

All diesel equipment requires periodic maintenance. Routine maintenance and repairs help to ensure that engines operate at maximum performance and emission rates do not exceed the designed standard. Major maintenance intervals provide an opportunity to have the engine rebuilt to a more stringent "Tier," using more modern, cleaner components that provides an immediate emission reduction benefit. This technique is often employed for locomotive rebuilds.

Operational Strategies

In addition to the technological options described above, a variety of strategies that change the operating practices of diesel equipment can result in lower emissions. These strategies include: idling reductions, marine vessel speed reductions, on-dock rail, port gate improvements, and cold ironing. Some of these strategies involve improvements in operational efficiency that reduce costs for equipment operators.

¹⁷ Natural Resources Defense Council, *Harboring Pollution: Strategies to Clean Up U.S. Ports*, August 2004.

Idling Reductions

Reducing engine idling can be an effective way to reduce emissions while saving fuel and maintenance costs for the equipment owner. Diesel equipment often idles for extended periods, often to provide necessary power to operate heating, air conditioning, and other vital services, but sometimes unnecessarily. Training can help to encourage equipment operators to shut down the engine rather than idle unnecessarily. Some on-road truck engines are now equipped with automatic shut-down devices that turn off the engine after a specified time of non-use. For provision of necessary power, an auxiliary power unit (APU) can be used to provide power during idling. APUs typically produce far fewer emissions of PM, NOx, and other pollutants, and have been commercially applied to both trucks and locomotives.

Cold Ironing

Ships typically run their auxiliary engines while docked (termed “hotelling”) in order to provide electrical power to the ship for climate control, lighting, cargo refrigeration, on-board cargo handling equipment, and other uses. Hotelling emissions can make up a major portion of total port emissions. For example, hotelling emissions account for 32 percent of all marine vessel NOx emissions at the Port of Houston and nearly 20 percent at the Port of Los Angeles.^{18 19}

Cold ironing, or vessel electrification, involves retrofitting ocean going vessels to allow them to receive shore power to meet their energy needs while docked at the port, thus allowing them to shut off their auxiliary engines.²⁰ This strategy is most effective for ports and vessels that generally have long hotelling times, multiple annual vessel calls, and high auxiliary power needs.

Cold ironing has been successfully implemented for all Princess cruise ships in Juneau, Alaska; some dry bulk vessels in Pittsburg, California; most U.S. Navy terminals; and elsewhere. The Port of Los Angeles has signed a memorandum of understanding with six shipping lines to promote the use of cold ironing, and the China Shipping terminal there docked its first commercial container ship using cold ironing in June 2004.²¹ The Port of Seattle plans to implement cold ironing for cruise ships in 2005.²²

Marine Vessel Speed Reductions

Reducing ship speed typically reduces emissions. Ships calling on a port travel at cruise speed in open water before entering a port’s “reduced speed zone.” Vessel speed reductions can be promoted by expanding the reduced speed zone further into the cruise region or lowering the specified reduced speed. For example, the Ports of Los Angeles and Long Beach have established a Voluntary Commercial Ship Speed Reduction Program, which urges vessels to travel at or below 12 knots within 20 miles of the coast.

On-dock Rail

A large portion of import and export shipping containers are moved over land by railroads, particularly shipments longer than 500 miles. Typically, on-road trucks are used to transfer the containers between the port and an intermodal rail facility. Ports that are served by a railroad have the opportunity to move

¹⁸ Starcrest Consulting Group, *Houston-Galveston Area Vessel Emissions Inventory*, Prepared for the Port of Houston Authority, 2000.

¹⁹ Starcrest Consulting Group, *Port-Wide Baseline Air Emissions Inventory*, Prepared for the Port of Los Angeles, 2004.

²⁰ The term “cold ironing” was derived from the notion that the ship’s metal (iron) becomes “cold” while the vessel’s engines are shut off and shore-based power is applied.

²¹ Natural Resources Defense Council, *Harboring Pollution: Strategies to Clean Up U.S. Ports*, August 2004.

²² *Argus Air Daily*, Vol. 11, 187, September 30, 2004.

shipping containers directly between rail cars and marine vessels, eliminating the movement of on-road trucks. Because trucks serving ports tend to be among the oldest and highest polluting trucks in operation, use of on-dock rail can be an effective way to reduce emissions while reducing port-area road congestion. A recent container terminal development at the Port of Seattle was built with on-dock rail.²³

Port Gate Improvements

When ports do not provide enough gates or operate their gates during limited hours, trucks serving the port may be forced to wait in queues that sometimes back up for miles, causing unnecessary truck idling and emissions. Congestion at port gates is, in part, related to the peaks in daily traffic caused by demand for morning pickups and afternoon deliveries. At many ports, terminal gates are typically open during normal business hours, sometimes on a 9 a.m. – 5 p.m. schedule, even when steamship lines unload containers for extended hours. Labor agreements sometimes prevent ports from expanding the hours of gate operation.

Many larger port terminals are experimenting with longer operating hours as a way to reduce truck congestion, with some success. However, truckers serving ports cannot shift to off-peak hours unless freight recipients are willing to extend their dock operating hours. Some port terminals have extended their gate hours, only to find that demand is insufficient to justify the added cost.

Another option for minimizing port access delays is to use an appointment system whereby truckers schedule pick-up times in advance. This can help terminals spread truck arrivals throughout the day. Port terminals can also streamline truck access by using automated clearing procedures. The Port of Houston, for example, is building a new pre-check gate facility at the Barbours Cut Container Terminal that is expected to reduce processing times for entering trucks from 22 minutes to 6 minutes. This improvement should help reduce congestion and idling time at the facility.

Productivity Improvements

Operational strategies can improve the productivity of ports and construction activity, resulting in lower emissions. A productivity improvement generally means obtaining more output for a given level of input. Ports can improve productivity in a variety of ways, often facilitated by the use of new technologies such as improved cranes. When operational strategies allow ports to handle the same amount of cargo in less time or with less equipment activity, the result is often a reduction in fuel use and emissions. Operational practices can also sometimes be employed to reduce equipment use and emissions associated with construction work.

2.5 Current EPA Efforts to Address Emissions from In-Use Diesel Engines

EPA has a number of on-going initiatives that support efforts to reduce emissions from in-use diesel engines. This section describes two such programs. EPA also administers several grant programs focused on diesel emission reduction; these are described in Section 3.1.

Voluntary Diesel Retrofit Program's Technology Verification Process

As part of the Voluntary Diesel Retrofit Program, EPA oversees a process to verify the emission reductions that can be achieved using a particular technology in a particular application. This is known as the Environmental Technology Verification (ETV) process. When a state takes credit in a SIP for a program to reduce emissions from diesel equipment, the state must be confident that the emission

²³ Natural Resources Defense Council, *Harboring Pollution: Strategies to Clean Up U.S. Ports*, August 2004.

reductions will materialize. Similarly, when specific technologies are employed in any type of retrofit program, knowledge of the anticipated emission reductions is usually paramount. Manufacturers of products to reduce diesel emissions sometimes exaggerate a product's effectiveness or have not sufficiently tested the product under different operating conditions. The ETV process applies rigorous testing procedures to determine the amount of emission reduction that equipment owners are likely to see in real-world application of the product (although the testing is performed in a laboratory setting), and it also verifies that the performance of the technology is maintained over time.

The ETV program verifies emission reductions from after-treatment technologies, use of cleaner fuel, and emission reducing fuel additives (without engine conversion). ETV may also be used to verify emission reductions from engine rebuild kits, engine upgrades, conversion of any engine to a cleaner fuel, and early replacement of older engines with newer cleaner engines, although to date none of these latter four techniques has been subject to the ETV process. The ETV process is voluntary, initiated and paid for by manufacturers. The cost can be considerable for manufacturers, sometimes \$500,000 or more for a new technology.

When a manufacturer applies to the ETV program, EPA first determines whether the manufacturer can submit testing data directly to EPA or must go through a laboratory that is evaluated under the ETV program and determined to be capable of performing the Federal Test Procedure. A manufacturer is typically allowed to submit test data directly to EPA if the manufacturer has been through a similar test protocol recently for which compliance documents were submitted to EPA, can demonstrate the ability to perform the tests at the manufacturer's facility and prepare the documentation to EPA specifications, and is willing to undergo quality audits. Otherwise, the manufacturer must work with a qualified laboratory to perform the tests and prepare the documentation.

After the EPA verification process is complete, the new technology is added to EPA's Verified Technology List. This list describes the emission reduction capability of the product, lists compatible engine family(s) and family group(s) and associated emission reduction levels, and defines operating criteria and limitations. After a verified technology is put into use, the ETV process requires the manufacturer to perform in-use testing to ensure that emission reduction levels are maintained in the field over time.

In California, CARB performs a similar process called the Diesel Emissions Control Strategy Verification Procedure. Although EPA assigns percent reductions of each pollutant for a certified technology, CARB certifies technologies as meeting one of three levels for PM emission reduction, as shown in Table 2-2.

Table 2-2: CARB Emission Reduction Classifications

Pollutant	Reduction	Classification
PM	< 25%	Not Verified
	≥ 25% and < 50%	Level 1
	≥ 50% and < 85%	Level 2
	≥ 85% or ≤ 0.01 g/bhp-hr	Level 3
NOx	< 15%	Not Verified
	≥ 15%	Verified in 5% increments

The EPA and CARB processes have some other differences. For example, CARB requires a review of possible multimedia effects for fuel-based technologies, while EPA does not require such review. CARB

also allows chassis dynamometer tests, while EPA allows only engine dynamometer tests. Although a large number of products have been verified by EPA and CARB for on-road use, few have been verified for off-road use. Table 2-3 lists these technologies as of April 2005 and the verified reduction in PM and NOx emissions.²⁴

Table 2-3: EPA and CARB Verified Technologies for Off-Road Use (as of April 2005)

Technology	Manufacturer	Product Name	Verified Reduction		Application	Fuel
			PM	NOx		
<i>EPA Verified</i>						
Emulsified diesel fuel	Lubrizol	PuriNOx	16.8 - 23.3%	17.0 - 20.2%	All off-road diesel engines	Emulsified fuel
<i>CARB Verified</i>						
DOC	Donaldson	Series 6000 plus Spiracle Crankcase Filter	at least 25%	-	Certain 1996-2003 off-road engines used in yard tractors, large lift trucks, top picks, side picks, and gantry cranes	CARB diesel or 15 ppm sulfur
DOC	Lubrizol	AZ Purimuffler, AZ Purifier	at least 25%	-	Certain 1996-2002 off-road port, railway yard, and other intermodal freight handling equipment	15 ppm sulfur
DOC plus emulsified diesel fuel	Lubrizol	PuriNOx plus AZ Purimuffler or AZ Purifier	at least 50%	20%	Certain 1996-2002 off-road port, railway yard, and other intermodal freight handling equipment	Emulsified fuel
DPF	Lubrizol	Unikat Combifilter	at least 85%	-	Certain 1996-2004 off-road construction, material handling, and cargo handling equipment	CARB diesel or 15 ppm sulfur
DPF	CleanAIR Systems	PERMIT	at least 85%	-	Certain 1996-2003 off-road engines used in stationary emergency generators	15 ppm sulfur
DOC and SCR	Extengine Transport Systems	Advanced Diesel Emission Control (ADEC) System	at least 25%	80%	Certain 1991-95 Cummins off-road engines used in excavators, dozers, loaders, and utility tractor rigs	CARB diesel or 15 ppm sulfur

Note: DOC = Diesel oxidation catalyst; DPF = Diesel particulate filter; SCR = Selective catalytic reduction

²⁴ The EPA and CARB verified technology lists are frequently updated. See the following Internet sites for the most recent information: www.epa.gov/otaq/retrofit/retroverifiedlist.htm; www.arb.ca.gov/diesel/verdev/verdev.htm (for devices); www.arb.ca.gov/fuels/diesel/altdiesel/altdiesel.htm (for fuels).

In June 2004, CARB and EPA announced a Memorandum of Agreement that establishes reciprocity in verifications of hardware or device-based retrofits. The agreement commits CARB and EPA to work toward accepting PM and NOx verification levels assigned by the other's verification program and commits the two agencies to cooperate on the evaluation of other retrofit technologies, including fuel-based strategies. Before this agreement, most manufacturers had to pursue verification from the two agencies separately. This agreement will help to expedite the verification and introduction of new emission reduction technologies by reducing verification time and expense for manufacturers. Note that Texas' New Technology Research and Development Program (described in Section 3.3) provides financial assistance for companies trying to complete testing for EPA or CARB verification.

SmartWay Transport Partnership

SmartWay Transport is a voluntary partnership between EPA and various freight industry stakeholders that creates incentives for fuel efficiency improvements and greenhouse gas emission reductions. The partnership, officially launched in February 2004, is open to both freight carriers (e.g., trucking companies and railroads) and freight shippers (e.g., manufacturers or retailers). SmartWay Partners commit to improve the environmental performance of their freight delivery operations. In turn, they benefit from an enhanced public image. Freight carriers can gain additional financial benefits through the adoption of fuel-saving practices. The SmartWay program is currently working with its partners to identify voluntary emission reduction opportunities in the maritime freight sector.

EPA has developed the Freight Logistics Environmental and Energy Tracking (FLEET) Performance Model to assist trucking companies in quantifying their current fuel use and emissions, as well as evaluating the costs and effectiveness of emission reduction strategies that they might adopt in the future. To become a SmartWay Transport Partner, carriers measure their current environmental performance and commit to improve that performance within three years. Some examples of fuel saving strategies employed by SmartWay carriers include idle reduction, improved aerodynamics, driver training, and the use of low-viscosity lubricants.

A freight shipper can become a SmartWay Transport Partner by committing to ship at least 50 percent of its goods with SmartWay Transport Partner carriers. SmartWay shippers also agree to assess and commit to improve their facility transportation emissions within 3 years. Strategies to reduce shipper facility emissions include scheduling of pick-up and delivery times, use of electric forklifts, and idle reduction at loading docks. As of December 17, 2004, the SmartWay Transport Partnership had signed up 115 partners, including 89 trucking companies, 20 shippers, and six shipper-carriers (shippers that operate their own trucking fleets, as well as ship freight through contract carriers).

Another component of the SmartWay Transport Partnership seeks to eliminate unnecessary truck and rail idling. To achieve this, SmartWay is working to develop a nationwide network of idle-reduction options along major transportation corridors, such as at truck stops, distribution hubs, and rail switch yards. Funding also is available through SmartWay to facilitate deployment of idle-reduction technologies. EPA recently awarded \$1 million in grants to nine states and non-profit organizations to study the effectiveness of using technologies such as truck stop electrification and shore power to decrease engine idling.

2.6 Other Government Regulations Affecting Off-Road Diesel Emissions

A number of state and local government regulations potentially affect off-road diesel emissions, including regulations in California, proposed legislation in New Jersey, and a variety of anti-idling laws.

California's Diesel Risk Reduction Program

CARB is pursuing an aggressive program to reduce diesel emissions in California. In 2000, CARB adopted the *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-fueled Engines and Vehicles*. The adoption of this plan was prompted by California's identification of diesel exhaust as a toxic air contaminant in 1998. The Risk Reduction Plan establishes a goal of reducing diesel PM 75 percent by 2010 and 85 percent by 2020, as compared to 2000 baseline emissions. In order to achieve this goal, CARB has adopted several regulations that apply to in-use diesel engines and vehicles, including:

- Waste collection trucks
- Transit buses
- School buses (idling restrictions)
- Stationary engines
- Transportation refrigeration units
- Portable engines

Most of these regulations require the use of retrofitting, repowering, and/or alternative fuels to achieve emission reductions. CARB is considering regulations that would reduce emissions from in-use construction and agricultural equipment, marine vessels, and port cargo handling equipment.²⁵ California's diesel risk reduction program also includes strict diesel fuel sulfur limits. As described in Section 2.2, CARB regulations require ULSD for both on-road and off-road engines beginning in 2006.

New Jersey Legislation (Proposed)

In his State of the State address in January 2004, former New Jersey Governor James McGreevy pledged to cut New Jersey's smog and soot air pollution by 20 percent over 10 years. Following on this pledge, legislation was introduced in the New Jersey legislature that would require certain on-road trucks, commercial buses, school buses, sanitation vehicles, and off-road diesel equipment to have the "best available retrofit technologies" by January 2009. The bill would primarily target fleets of 10 or more on-road diesel vehicles that are registered or operated in New Jersey.

The state Department of Environmental Protection (DEP) would determine the choice of technologies for each vehicle and piece of equipment. The technologies could be equipment, fuel, or a combination of the two. The bill would also require the use of ULSD in on-road and off-road vehicles and equipment; this requirement would take effect one year after the date of enactment. To mitigate the cost of retrofits, the bill would create an income tax deduction for the cost of purchasing and installing any technology required by the bill, but not for any additional fuel costs.

At a July 2004 hearing before the New Jersey Senate's Environment Committee, critics of the bill expressed doubts about whether the retrofit requirements could be enforced on out-of-state vehicles under the federal Clean Air Act and the Constitution's interstate commerce clause. They also expressed concerns about the availability of ULSD and the potential effects the legislation would have on the competitiveness of New Jersey's trucking companies and its ports. It is currently unclear if the bill will become law in New Jersey, and if it does, whether it will survive legal challenges.

²⁵ For updated information on the CARB program, see <http://www.arb.ca.gov/diesel/dieselrrp.htm>

State and Local Anti-Idling Regulations

A number of states have adopted laws that limit vehicle and equipment idling.²⁶ Many of these laws apply to both on-road and off-road vehicles. California is the largest jurisdiction to adopt strict idling restrictions. In July 2004, CARB adopted a rule that limits heavy-duty trucks and buses to five minutes of idling anywhere in the state, although the rule exempts trucks with sleeper cabs. The rule does not apply to trucks idling due to road congestion, trucks waiting in queues, or trucking using certain types of equipment. CARB and the state's regional air districts will enforce the rule when it takes effect in early 2005, levying a \$100 fine per violation.

Although the California regulation does not apply to off-road engines, other states have anti-idling laws that do regulate off-road equipment. Connecticut, for example, limits idling of all mobile source engines to three minutes. Enforcement of these anti-idling regulations reportedly varies widely. Many of these laws have been adopted only recently, and some jurisdictions have not yet established procedures for enforcing the restrictions.

²⁶ For a list of many of these laws, see <http://www.epa.gov/otaq/smartway/idle-state.htm>

3 FEDERAL, STATE, AND LOCAL GRANT PROGRAMS

Grant programs provide funding directly to equipment owners to allow them to purchase cleaner equipment, cleaner engines, after-treatment retrofits, or cleaner fuels. In most cases, grant programs attempt to cover the incremental cost of a lower emissions technology. Diesel emission reduction grant programs are run by EPA, states, regional air quality districts, cities, and ports.

The two major statewide grant programs are the Carl Moyer Program in California and the Texas Emissions Reduction Plan. Several other states have grant programs, including Washington and New York, but given the size, importance, and success of the California and Texas programs, we focus on these two. We also review selected regional and port-run grant programs, including several that focus on highway trucks but offer some possible lessons for the off-road sector.

3.1 EPA Grant Programs

EPA has implemented a number of grant programs to promote reductions in diesel emissions. Many of these are considered part of EPA's Voluntary Diesel Retrofit Program. EPA's SmartWay program is also providing grants to reduce truck idling.

Clean School Bus USA Program

Clean School Bus USA is a public-private environmental partnership administered by EPA that seeks to reduce children's exposure to air pollution from diesel school buses. Funding comes from EPA and from several states and private groups. The program emphasizes three ways to reduce public school bus emissions:

1. anti-idling strategies
2. engine retrofits and use of clean fuels
3. replacement of pre-1990 buses

Although EPA has mandated more stringent emissions standards for heavy-duty vehicles, including school buses, to take effect in 2007, the Clean School Bus USA program hopes to jump-start the process of upgrading the nation's public school bus fleet to run more cleanly in the near-term. In the first two

Key Findings on Grant Programs

1. *California's Carl Moyer and Texas' TERP programs are highly successful and deserve replication in other states. These programs award grants on a competitive basis for purchasing cleaner equipment or for repowering or retrofitting existing equipment. Both have distributed more than \$100 million in grants to date, primarily for projects that reduce NOx emissions from diesel engines. These programs require committed funding, however, and are unlikely to be a high priority in many states experiencing budget shortfalls.*
2. *A grant program should offer flexibility, rather than promote a particular technology or focus on a particular type of equipment. Grant programs work best when they allow equipment owners to make their own decisions about methods for achieving emission reductions. Using emission reduction cost-effectiveness as a criterion to select grant recipients can help to maximize emission reductions with the available funding. Other criteria should also be considered, including nonattainment status, equity issues, and population exposure information.*
3. *Grant programs require considerable government time and resources to administer. Agencies need to design a program that is equitable and cost-effective, considering the structure of equipment ownership and related costs. They need to promote the program to attract sufficient applications, then evaluate applications and make awards. Finally, they need to monitor use of the grant funds and ensure that recipients are complying with the program's conditions concerning equipment use.*
4. *It is important to consider the unique needs of small businesses when designing a grant program. Restrictions on equipment use or a lengthy application process, for example, can burden a small construction company more than a large one. Public agencies should keep in mind that many small businesses may find the grant application and award monitoring process onerous and may need assistance in completing the application.*

years of the program (2003 – 2004), EPA provided approximately \$10 million in school bus retrofit and replacement grants, funding 37 demonstration projects around the nation involving more than 8,000 buses. Grant recipients contribute 5 percent matching funds. In fiscal year 2005, the Clean School Bus USA program has \$7.5 million in competitive grants for school districts to upgrade their diesel fleets. EPA has also provided school bus grant funding through the Diesel Retrofit Grants program (described further in this section). School bus retrofits are also being funded through a Supplemental Environmental Project, as described in Section 7.4.

West Coast Collaborative

As part of the national Clean Diesel program, the West Coast Collaborative brings attention to the need for additional funding for diesel emission reduction on the West Coast and encourages voluntary and incentive-based projects that reduce diesel emissions. The Collaborative is focused on projects that are regional in scope, leverage funds from a variety of sources, result in measurable results, and create momentum for future diesel emission reductions. Led by EPA Regions 9 and 10, the Collaborative includes other federal agency partners (U.S. Department of Agriculture's Natural Resource Conservation Service, U.S. Department of Energy, and U.S. Department of Transportation), Canada and Mexico, plus state environmental agencies and local air quality districts.

The Collaborative was initiated in April 2004. Its goal is to leverage over \$100 million per year for five years to reduce emissions from the most polluting diesel sources in the most affected communities on the West Coast. The Collaborative will create additional incentives for early application of federal and state on-road and off-road diesel engine and fuel standards and greater participation in voluntary diesel mitigation programs. The Collaborative will employ innovative technologies and will support activities that reduce emissions from diesel sources by leveraging existing programs and funding sources. The Collaborative will also work to secure new funding opportunities.

As part of the Collaborative, EPA Regions 9 and 10 are currently offering grants to support regional collaborative demonstration projects that reduce diesel emissions. EPA expects to award approximately \$1 million in grant funds through this program.

Diesel Retrofits to Benefit Sensitive Populations

These grants are used to demonstrate innovative application of EPA verified pollution control equipment in reducing emissions from diesel fleets, including non-road fleets, that affect sensitive populations – such as children, the elderly, and the chronically ill – who are more susceptible to the effects of diesel exhaust. Applications were solicited from state, local, multi-state, and tribal agencies and non-profit organizations. In February of this year, EPA announced the award of \$1.6 million to 18 grantees, with funding up to \$150,000 per grant.

Diesel Retrofit Grants

EPA awarded grant funding for two new diesel retrofit projects. One grant provides \$100,000 to the Lane Regional Air Pollution Authority in Oregon to demonstrate the use of ULSD with a wide variety of non-road equipment and heavy-duty highway vehicles in Oregon. The funds will help local agencies and fleets pay for the difference in cost between regular highway fuel and ULSD. A second grant of \$100,000 to the Chattanooga-Hamilton County Air Pollution Control Bureau will fund a public/private partnership retrofit project involving school buses.

EPA Regional Grants

Several EPA regions administer grant programs. For example, the Region 10 Regional Geographic Initiative is a grant program that targets geographically unique or sector-based projects that fill critical gaps in EPA's ability to protect human health and the environment in Alaska, Idaho, Oregon and Washington. Individual grants range from \$10,000 to \$50,000. In Fiscal Year 2004, EPA funded eight projects totaling \$400,000.

3.2 Carl Moyer Memorial Program

California's Carl Moyer Memorial Air Quality Standards Attainment Program (the Moyer Program) is the first successful statewide program providing grants to promote diesel emission reductions. The program began in 1998 and since then has provided more than \$150 million in awards to California-based individual and business applicants, both private and public sector. The Moyer Program can be used to fund vehicle and equipment replacement, repowering, or retrofits. The program funds are used to offset the incremental costs of heavy-duty vehicles and equipment that emit less NOx than the current year's standards from the following categories:

- On-road motor vehicles (gross vehicle weight rating (GVWR) > 14,000 lbs.)
- Off-road equipment (> 50 hp)
- Marine vessels
- Locomotives
- Stationary agricultural pump engines
- Forklifts
- Airport ground support equipment
- Heavy-duty auxiliary power units

State-Level Funding and Administration

CARB oversees the Moyer Program, establishing program guidelines and distributing funds to the state's air quality management districts. The regional districts are then responsible for soliciting proposals and awarding funds, in accordance with CARB's general guidelines. CARB distributes funds to the districts based on two criteria:

1. Attainment status of the federal ozone standard
2. Population

Each district is eligible to receive a minimum funding allocation (currently \$100,000, but set to increase to \$200,000 in 2006). More populous districts and those in ozone non-attainment status are eligible to receive additional funding.

The Moyer Program has a local matching requirement of approximately \$1 of local funds for every \$2 of Moyer Program funds in order to demonstrate appropriate commitment for program administration and implementation. Due to an increase in state funding in the program's third year, districts found it increasingly difficult to meet the matching fund requirement. To ease this financial burden, the state legislature capped the matching fund requirement at \$12 million, as if the total program budget were \$25 million, the first year funding. The state further alleviated the burden on smaller districts that receive only

the minimum allotment by waiving their matching fund requirement. In order to continue to demonstrate a district's commitment to the program, each district must participate in training by CARB staff on administrative and reporting procedures.

CARB distributes the full minimum allocation at one time to districts receiving only the minimum funding amount; for districts receiving more than the minimum allocation, an initial 10 percent of the total funding is disbursed with the remaining funds distributed on an as-needed basis as determined by CARB. In order to encourage districts to implement their local programs quickly and to have all funds obligated within one year, CARB requires districts to report project status and remaining funds that have not yet been obligated. Any unobligated funds at the end of the fiscal year may be reallocated by CARB.

Funding is allocated to the Moyer Program as part of the legislative budget, so program funding has fluctuated. A total of nearly \$152.5 million has been allocated to the program through 2004. Moyer Program funding is expected to significantly increase up to \$140 million annually in 2005. Table 3-1 shows historical funding fluctuations.

It should be noted that new legislation passed at the end of September 2004 significantly changes the program. Primarily, the bill expanded the Moyer Program to include emissions reduction projects exclusively for PM or hydrocarbons (HC) (previously all projects had to also reduce NOx) and to open funding up to light- and medium-duty vehicle retrofits, repowers, and replacements. The revised Moyer Program also allows for funding for a broader variety of agricultural projects. In addition, the law provides additional funding from an adjustment to the tire fee and allows districts to raise motor vehicle registration fees by \$2 to raise matching funds for the program. Lastly, it establishes a new formula for CARB to distribute funds to the districts to be effective January 1, 2006.

Table 3-1: Moyer Program Historic Funding Amounts

	FY98 – 99	FY99 - 00	FY00 - 01	FY01 - 02	FY02 - 03	FY03 - 04	Total
Air Districts	\$24,500,000	\$18,620,000	\$44,100,000	\$15,680,000	\$19,680,000	\$18,000,000	\$140,580,000
Calif, Energy Commission	-	\$4,000,000	\$5,000,000	-	-	-	\$9,000,000
CARB admin	\$500,000	\$380,000	\$900,000	\$320,000	\$400,000	\$400,000	\$2,900,000
Total	\$25,000,000	\$23,000,000	\$50,000,000	\$16,000,000	\$20,080,000	\$18,400,000	\$152,480,000

Source: Based on *The Carl Moyer Program Annual Status Report*, February 2004.

Project Selection Process

Projects are determined by the districts at the local level, with CARB approval when necessary. Legislation has mandated the following minimum program requirements; local districts may apply more restrictive requirements:

- Replacement projects must replace an old engine/vehicle with a newer one certified to more stringent standards. Retrofit and repower projects must use equipment certified by CARB to reduce NOx emissions by at least 15 percent with no increase in other emissions.
- Projects must meet a cost-effectiveness threshold of \$13,600 per ton of NOx reduced.
- At least 75 percent of the vehicle miles traveled or hours of operations must be in California for a minimum of 5 years following the grant award. For marine vessel projects, the time the vessel(s)

spends at dock in California must meet an acceptable level to achieve the 15 percent NOx reduction in California. Most regional air districts require that at least 75 percent of the vehicle or equipment annual hours of operation, miles traveled, and fuel consumption be within the air district boundaries for a minimum of five project years.

- Projects must have a minimum project life of five years. If the project is ended prematurely or if the stated emission reductions are not attained at the end of the project life, the funding recipients must return a prorated portion of the Moyer Program funds.
- Beginning in FY2000-2001, the Moyer Program encouraged a program-wide PM reduction target of 25 percent. This PM reduction target is required for local programs in areas designated as being in serious non-attainment of the federal PM-10 standard, currently the South Coast Air Quality Management District and the San Joaquin Valley Unified Air Pollution Control District.²⁷

In addition, districts with greater than one million residents must allocate at least 50 percent of their Moyer Program funds to projects that address environmental justice concerns – i.e., the projects must benefit low-income communities and communities of color that are disproportionately affected by air pollution. Districts have the discretion to define the applicable communities and projects; however, CARB offers guidance and requires reporting to ensure compliance with the environmental justice requirements.

CARB authorizes and encourages districts to impose additional or more stringent requirements in order to ensure the greatest emission reductions per dollar. Provided proposed projects meet the above requirements, districts may select projects based on one or more of the following criteria:

- Local priorities
- First come, first served
- Cost-effectiveness (beyond the \$13,600 per ton of NOx reduced threshold)

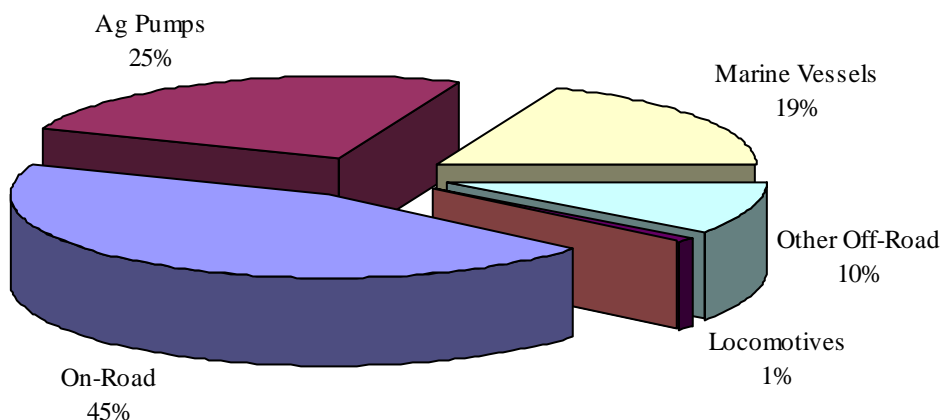
After the projects have been implemented, districts must monitor the projects to ensure they are meeting their intended emission reductions over the life of the projects (to date, up to 20 years).

Distribution of Funds

The program's success was last documented in February 2004 for the first four years of the program (1998 through 2002). At that time, districts had funded projects from every Moyer category except airport ground support equipment, representing a total of approximately 4,950 on-road and off-road engines. Projects included repowers of approximately 2,870 diesel engines and 2,080 engine replacements with new alternative fueled or electric engines.²⁸ Figure 3-1 shows Moyer Program funding allocation by source type.

²⁷ Note that PM reduction goals or requirements (depending on PM non-attainment status) are to be implemented on a program-wide, rather than a project, basis. NOx reductions, however, are required at the project-level.

²⁸ California Air Resources Board (ARB), *The Carl Moyer Program Annual Status Report*, February 2004.

Figure 3-1: Moyer Program Funding by Source Type, 1998 – 2002

As of February 2004, over 90 percent of Moyer Program funding was allocated for heavy-duty engine projects. Forty-five percent of funding has gone to on-road vehicle projects, and 25 percent has gone to agricultural pump projects. Approximately 19 percent of total funds have gone to marine vessels. Only about 5 percent of funds have gone to construction equipment projects. Table 3-2 shows project funding by detailed source categories and engine type.

Table 3-2: Type and Number of Engines Funded by Moyer Program Statewide, 1998 – 2002

Source Category/ Equipment Type	Number of Engines		Funding ^a		Total
	Alt Fuel	Diesel	Alt Fuel	Diesel	
On-Road Vehicles					
Line Haul Trucks	87	49	\$3,826,637	\$1,081,315	\$4,907,952
Refuse Haulers	668	37	\$20,253,546	\$684,830	\$20,938,376
Transit Buses	778	4	\$11,309,741	\$93,318	\$11,403,059
School Buses	20	0	\$401,551	\$0	\$401,551
Other	177	65	\$3,401,753	\$1,141,384	\$4,543,137
<i>On-Road Subtotal</i>	<i>1,730</i>	<i>155</i>	<i>\$39,193,228</i>	<i>\$3,000,847</i>	<i>\$42,194,075</i>
Off-Road Vehicles and Equipment					
Agriculture	1	89	\$2,800	\$912,210	\$915,010
Construction	0	106	\$0	\$4,498,869	\$4,498,869
Other	76	27	\$1,385,740	\$913,726	\$2,299,466
Ag Pumps	56	2,150	\$1,141,567	\$22,543,840	\$23,685,407
Locomotives	2	21	\$820,000	\$299,985	\$1,119,985
Fork Lifts	211	0	\$1,904,403	\$0	\$1,904,403
Marine Vessels	0	319	\$0	\$17,429,687	\$17,429,687
<i>Off-Road Subtotal</i>	<i>346</i>	<i>2,712</i>	<i>\$5,254,510</i>	<i>\$46,598,317</i>	<i>\$51,852,827</i>
Total	2,076	2,867	\$44,447,738	\$49,599,163	\$94,046,901

Note a: Based on projects funded or with grant commitments in February 2004. Approximately \$9 million of the first four years of funding had yet to be committed at the time the table was developed.

Source: Modified from *The Carl Moyer Program Annual Status Report*, February 2004.

In its first four years of operation, Moyer Program projects were estimated to reduce NOx emissions by more than 5,100 tons per year (roughly 14 tons per day) at an average cost-effectiveness of approximately \$3,000 per ton, far less than the \$13,600 per ton of NOx reduced cost-effectiveness statutory threshold. In addition, diesel PM was reduced by approximately 260 tons per year, or about one ton per day. In the third and fourth program years, the two districts required to meet the 25 percent PM reduction target for their local Moyer programs surpassed the 25 percent goal. In the South Coast AQMD, Moyer Program projects were projected to reduce PM by an average of 33 percent in FY2000-2001 and 89 percent in FY2001-2002. During these two years, the San Joaquin Valley APCD projected PM reductions of 43 percent and 48 percent, respectively.

Discussion of Interview Findings

The Moyer Program is widely recognized as a success by air quality agencies, ports, and construction industry stakeholders. Air quality management districts in California have been able to use the program to achieve substantial reductions in NOx and PM emissions, thereby gaining badly needed SIP credits. Industry stakeholders generally value the program's flexibility and emphasis on cost-effective emission reductions, rather than promoting a particular emission reduction technology or targeting a particular industry sector. The fact that the program has been well-funded through six years contributes to perceptions that it is a stable, reliable, and well-run program.

While nearly all interviewees expressed satisfaction with the Moyer Program, some did identify shortcomings and related difficulties. Some construction companies report difficulty complying with the requirement that 75 percent of equipment usage occur within the boundaries of the air district providing the funding. Some construction companies operate over an area larger than an air district, and this requirement constrains their ability to move equipment between job sites. This can be particularly difficult for companies that are located in relatively small districts (e.g., Ventura County) or located near their district's border. (The TERP program provides more flexibility with respect to equipment usage, as discussed in Section 3.3.)

Some construction companies have also expressed dissatisfaction with the funding caps imposed by some air districts. For example, the San Joaquin Valley air district limits awards to \$40,000. This amount will cover most of the cost of repowering an agricultural pump, but only about one-third the cost of repowering a scraper. Although the scraper repower can provide more cost-effective emission reductions that, thus, score higher in the project selection process, construction companies typically do not apply for the grants because of the cap on the award.

The length of the application process can serve as a disincentive to some applicants, particularly small companies. The time from submittal of an application to award of funding can be a year. Smaller construction companies need to plan for equipment being out of service for retrofits or repowering in order to schedule work accordingly. Larger companies often have more flexibility with their equipment and thus, are better able to cope with a lengthy application process. However, the Moyer Program does allow a company to substitute another piece of equipment if the original piece is no longer available for retrofit or repowering (e.g., if the equipment has been retired or cannot be removed from service). This type of flexibility is important to construction companies.

Several other characteristics of the Moyer Program reportedly make it difficult for smaller companies to win grants. For example, because smaller companies often use equipment less intensively than larger companies (fewer hours of operation per year), they have more difficulty achieving the cost-effectiveness criterion needed to qualify for awards. Also, some companies find the application process and reporting requirements daunting. In some air districts, there have been multiple diesel emission reduction grant

programs in place simultaneously, and companies find it hard to keep track of the application deadlines and requirements. Even larger companies sometimes hire consultants to handle their applications.

3.3 Texas Emissions Reduction Plan

The Texas Emissions Reduction Plan (TERP) is the nation's other large grant program focused on diesel emission reductions. Originally modeled after the Moyer Program, TERP has awarded more than \$120 million in grants for diesel retrofits, repowers, and equipment replacement since 2001. Approximately two-thirds of this money has gone to off-road applications, including a large number of construction companies.

TERP is administered by the Texas Commission on Environmental Quality (TCEQ). It consists of several voluntary financial incentive and other assistance programs that are intended to reduce NO_x emissions in areas of the state that are in non-attainment of the federal ozone standard or close to violating the standard.²⁹ TERP also encourages the development of new clean technologies as an incentive to new business and industry development in Texas. Program funding was originally designed to be distributed among seven programs and administered by four state agencies and one state university research center. However, due to a revenue shortfall, three main programs are currently funded:

1. Emissions Reduction Incentive Grants Program
2. Small Business Grant Program
3. New Technology Research and Development Program

These programs are summarized in Table 3-3.

²⁹ The voluntary programs that operate as part of the TERP replaced two previous mandatory SIP measures that would have removed 35.2 tons per day (tpd) of NO_x by the end of 2007 from state non-attainment areas. The two former measures were 1) a construction and industrial equipment operation time restriction from 6 a.m. to 10 a.m. or 12 p.m. (depending on non-attainment area) daily and 2) mandatory replacement of diesel-powered construction, industrial, commercial, and lawn and garden equipment of 50 horsepower (hp) and above with newer Tier 2 and Tier 3 equipment within certain timeframes.

Table 3-3: Currently Funded TERP Programs

Purpose	Eligible Applicants	Program Requirements
<i>Emissions Reduction Incentive Grants Program</i>		
<p>To offset incremental costs of reducing NOx emissions from high-emitting diesel sources through:</p>	<p>Owners/operators of:</p> <ul style="list-style-type: none"> • on-road heavy-duty vehicles (GVWR ≥ 8,500 lbs) • non-road equipment (≥ 25 hp) • marine vessels • locomotives • stationary engines (≥ 25 hp) • supporting infrastructure 	<ul style="list-style-type: none"> • All projects (except demonstration and infrastructure projects) must meet the statutory cost-effectiveness threshold of \$13,000 per ton of NOx reduced; the limit in FY05 is \$7,000 per ton; the long-term program goal is \$5,000 per ton • The vehicle, equipment, or infrastructure must operate at least 75% of the time within eligible non-attainment or near non-attainment counties • For new purchases/leases, equipment must be 25% cleaner for NOx than current year’s standard • For replacements and repowers, new vehicle or equipment must be 25% cleaner for NOx than the old vehicle/equipment • For retrofits or add-ons, retrofitted engine must achieve a 25% reduction in NOx from original engine certification level • For repowers or replacements, old engines or vehicles/equipment must be scrapped, sold outside of Texas, or transferred out of the state • For qualifying fuel projects, contracts are limited to 2.5 years due to state fiscal policies, but there is no limit on applying for future grants • Grantees must allow third party audits to verify that they are using TERP funds in the manner in which they were intended • Grantees must follow usage reporting requirements
<p>Vehicle and equipment. Examples include:</p> <ul style="list-style-type: none"> • New purchase or lease • Replacement • Repower • Retrofit 		
<p>Infrastructure. Examples include:</p> <ul style="list-style-type: none"> • Refueling infrastructure • On-site electrification infrastructure • Idle reduction infrastructure 		
<p>Qualifying fuel purchases (not currently being accepted)</p>		
<p>Demonstration projects (not currently being accepted)</p>		

Table 3-3 (Continued): Currently Funded TERP Programs

Purpose	Eligible Applicants	Program Requirements
<i>Small Business Grant Program</i>		
<p>To help small businesses participate in the Emissions Reduction Incentive Grants Program for:</p> <ul style="list-style-type: none"> • Replacement • Repower 	<p>A person who:</p> <ol style="list-style-type: none"> 1) Owns and operates not more than two on-road vehicles or pieces of non-road equipment, one of which is <ul style="list-style-type: none"> • an on-road HDDV with a pre-1994 engine model, or • a non-road diesel-powered piece of equipment with an engine (25+ hp) with uncontrolled emissions 2) Has owned the vehicle or equipment for more than one year 	<ul style="list-style-type: none"> • The vehicle or equipment must be operated at least 75% of the time within eligible non-attainment or near non-attainment counties • Applications received on a first-come, first-served basis • Grantees must allow third party audits to verify that they are using TERP funds in the manner in which they were intended
<i>New Technology Research and Development Program</i>		
<p>To encourage the development of emission-reducing technologies that will support two types of projects:</p> <ul style="list-style-type: none"> • Those that may be funded under the Emissions Reduction Incentive Grants Program • Other new NOx reduction technologies that show commercialization potential 	<p>Developers/manufacturers of:</p> <ul style="list-style-type: none"> • Technologies developed and demonstrated by a vendor, but not yet verified or certified for emission reduction credits • Technologies that have been developed and warrant a demonstration of applicability • Technologies that require further development or development for other applications³⁰ <p>Those who conduct:</p> <ul style="list-style-type: none"> • Research for emerging technologies • Studies to improve air quality assessment and modeling 	<ul style="list-style-type: none"> • Applicants must demonstrate a strong commercialization plan • Applicants must demonstrate that the technology will be offered for sale in Texas as soon as practicable, but no later than five years after application is received

³⁰ Special consideration will be given to projects that reduce more than just NOx emissions.

TERP Funding Sources

Funding for the TERP programs has been derived from a variety of tax surcharges and inspection fees, as listed below:

- A 1.0 percent surcharge on the in-state retail sale, lease, or rental of new or used off-road diesel equipment. Effective July 2003, the surcharge increased to 2.0 percent, and a storage, use, and consumption surcharge was added.
- A 2.5 percent surcharge on the retail sale or lease of pre-1997 on-road diesel motor vehicles over 14,000 lbs. GVWR. Effective July 2003, a usage surcharge on these heavy-duty diesel vehicles (HDDVs) and a 1.0 percent surcharge for 1997 or later model year on-road HDDVs were added.
- A 10 percent surcharge on total registration fees for truck-tractor and commercial motor vehicles
- A \$10 fee on the inspection of commercial motor vehicles
- As of July 2003, a portion of the vehicle titling fee equal to \$20 out of the \$33 fee for applicants in non-attainment counties and \$15 out of the \$28 fee for applicants in attainment counties

Two other funding sources were envisioned when TERP was established but were later disallowed for legal reasons:

- A 1.0 percent surcharge on the user tax that is collected on construction equipment that is purchased out-of-state for use within the state. This was disallowed due to a legal interpretation.
- A \$225 fee on the inspection of out-of-state vehicles seeking registration in Texas. This was declared unconstitutional on the grounds that it violates the Commerce Clause and the Equal Protection Clause of the U.S. Constitution.

As a result of the lack of revenue from the disallowed out-of-state vehicle inspection fee and the user tax on construction equipment, the first program year (FY 2002) revenue was 85 percent lower than expected (\$20.4 million versus \$137 million).³¹ The reduced revenue threatened EPA approval of the Texas SIP. To compensate for the lack of funds from these two initial revenue sources, the state legislature authorized the use of a portion of the state vehicle titling fee, in addition to new and increased sales and use surcharges, to take effect in 2003.

Other legislative changes in 2003 included the addition of near non-attainment counties to the eligibility list, an increase in the types of eligible projects, and the addition of the Small Business Grant Program. Heavy- and light-duty vehicle reimbursement programs and three energy efficiency programs that were originally designed as part of TERP were eliminated from TERP funding. Currently, the TERP anticipates receiving approximately \$130 million per fiscal year through August 31, 2008. Historic funding levels are shown in Table 3-4.

³¹ Texas Commission on Environmental Quality (TCEQ), Strategic Assessment Division, *Texas Emissions Reduction Plan: Report to the 78th Texas Legislature, Executive Summary* (excerpt from full report), December 2002. SFR-079/02.

Table 3-4: Historic TERP Funding

Agency	FY02	FY03	FY04	Total
TCEQ	\$14,000,000	\$24,400,000	\$141,800,000	\$180,200,000
Texas Public Utilities Commission	\$1,500,000	\$1,600,000	\$0	\$3,100,000
Comptroller	\$3,200,000	\$5,400,000	\$0	\$8,600,000
Texas A&M Energy Systems Laboratory	\$182,000	\$285,000	\$950,421	\$1,417,421
Texas Council on Environmental Technology	\$1,500,000	\$2,600,000	\$0	\$4,100,000
Total	\$20,400,000	\$34,300,000	\$142,800,000	\$197,500,000

As of FY 2004, the TERP budget is allocated accordingly:^{32,33}

- Emissions Reduction Incentive Grants and Small Business Programs = 87.5 percent
- New Technology R&D = 9.5 percent (with a minimum of 20 percent to support air quality research in non-attainment areas)
- Administrative = 3 percent

Project Selection Process

TERP grants are awarded to three different recipient types:

1. owner/operators of eligible vehicles or equipment
2. small businesses
3. third-party public entities via intergovernmental agreements to administer TERP-like programs

Emissions Reduction Incentive Grants and Small Business Grants Program applications are solicited through separate Requests for Applications during each fiscal year. TCEQ also works throughout the fiscal year with interested public entities who submit third party proposals to use TERP funds for specific projects, source categories, or activities. Prior to the opening of the solicitation periods, TCEQ hosts a series of workshops around the state to disseminate program information to interested parties. Grants are awarded on a cost-competitive basis, in which most projects are required to meet a \$13,000 per ton of NO_x reduction threshold. All projects meeting this criterion are further prioritized based on cost-effectiveness. Based on the TERP's past success and growing popularity, the cost-effectiveness criterion was capped at \$7,000 per ton of NO_x reduced for the FY 2005 request for applications, with a long-term goal of \$5,000 per ton. In addition, infrastructure projects are only eligible for funding up to 50 percent of the eligible costs of the project.

Funding distribution may also be prioritized by geographic area. For example, the Austin and San Antonio areas have a commitment in their Early Action Compacts (EACs) to achieve 2 tons of NO_x emission reduction per day by the end of 2007 from TERP, whereas the Houston-Galveston area's one-

³² National Renewable Energy Laboratory (NREL), "Texas Emissions Reduction Plan (TERP)," PowerPoint presentation.

³³ TCEQ, Environmental Planning and Implementation Division, *Texas Emissions Reduction Plan Biennial Report to the Texas Legislature, December 2004*.

hour ozone SIP commitment for 2007 is 38 tons per day. Applicants must identify their primary area of operation in order to credit the projected emission reductions to the appropriate SIP or EAC.

Because program funding is received throughout the year, all grant awards are contingent on the receipt of sufficient revenue to cover the approved applications. Therefore, grant contracts may be initiated, but are subject to a Notice to Proceed from TCEQ once sufficient funds are received. TERP is a reimbursement program; therefore, payment is made after proper documentation of project expense is received and approved. Grant recipients may opt to receive payment directly or to authorize their dealer or service provider to receive funds on their behalf. For pass-through grants via third-party applicants, administrative costs of the third-party will not be refunded under the terms of the program. TCEQ will establish payment and reporting requirements for these third-party grants on a case-by-case basis.

Notice of funding available for small business grants is provided throughout the year. The goal of the Small Business Grants Program is to streamline the application process to make it easier for these applicants to participate in TERP. Therefore, small business grants are processed on a first come, first served basis once the cost-effectiveness criterion of \$13,000 per ton of NO_x reduced is met. Beginning in FY 2004, the cost-effectiveness threshold will be reduced to \$8,500 per ton of NO_x under the Small Business Program.

For all projects except demonstration projects, the grant recipient must agree to track the use of funded vehicles, equipment, infrastructure, and qualifying fuel for the life of the project, as well as monitor the NO_x emission reductions achieved. Monitoring reports must be submitted to TCEQ on a semi-annual basis. If a project does not reduce emissions by the amount specified in its funding contract, a prorated portion of the funds could be required to be returned to the state. Third-party contractors will conduct annual audits of grant recipients to ensure program compliance.

Distribution of Funds

From the beginning of the program through FY 2004 (as of January 2005), approximately 280 projects have been selected to receive funding under the Emissions Reduction Incentive Grants Program for a total of approximately \$120 million. Many of these projects involve multiple vehicles or equipment pieces. Figure 3-2 shows distribution of these awards by source type. Projects involving solely off-road equipment (primarily construction equipment) have been awarded 33 percent of funds. Another 33 percent of awarded funding has gone to projects involving on-road equipment. Twenty-nine percent of awards have gone to locomotive projects. More than 40 Associated General Contractors of America (AGC) member companies have been awarded a total of \$34 million in TERP funding.

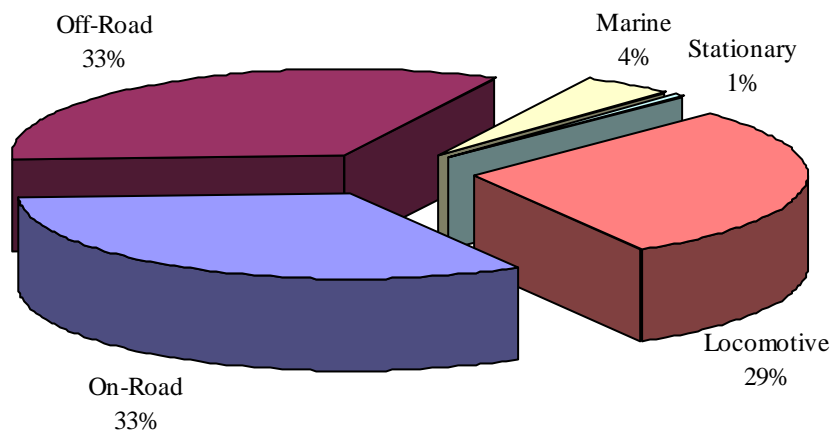
Figure 3-2: TERP Funding by Source Type, FY02 – FY04³⁴

Table 3-5 presents awarded TERP funds by project type and source category/equipment type. Most on-road vehicle projects involve retrofits or alternative fuels. In contrast, off-road projects are primarily purchase/replacement projects or engine repowers. The relatively small amount of funding awarded to off-road retrofits probably reflects the limited verified technologies for off-road use. Awards to the locomotive sector have been mostly the purchase of hybrid-electric “Green Goat” switch yard locomotives by railroad companies. Awards to the marine sector involve primarily vessel repowering. In total, approximately half of TERP awards have gone to new vehicle purchase or lease and vehicle replacement projects. Approximately 26 percent has gone to retrofit and fuels projects, and 21 percent to repowering. The average cost-effectiveness of TERP grants is approximately \$5,700 per ton of NO_x reduced.

Table 3-5: Use of TERP Funds by Project Type and Source Type, FY02 – FY04

Source Type	Project Type				Total
	Purchase/Lease/ Replacement	Repower	Retrofit/Fuels	Infrastructure/ Demonstration	
On-Road	1,851,763	2,908,368	28,798,065	5,754,362	39,312,558
Off-Road	27,382,232	10,470,456	1,665,807	739,000	40,257,496
Locomotive	27,982,500	6,504,000	333,025	283,969	35,103,494
Marine	0	4,991,548	400,000	0	5,391,548
Stationary	615,882	12,069	0	0	627,951
Total	57,832,377	24,886,442	31,196,897	6,777,331	120,693,047

Source: Data provided by Theresa Pella, TCEQ.

Another example of the TERP’s on-going success is the development of interagency agreements with interested public organizations. For example, in August 2004, TCEQ and the Railroad Commission of Texas (RRC) formed an agreement to allow RRC to use TERP funds for a forklift initiative program. The

³⁴ Data provided by Theresa Pella, TCEQ.

program will fund new purchase, replacement, repower, and retrofit projects that meet a \$5,000 per ton of NOx reduced cost-effectiveness threshold. TCEQ and the Dallas-Ft. Worth area's council of governments, North Central Texas Council of Governments (NCTCOG), are developing a similar agreement that would allow NCTCOG to use TERP funds for specific projects.

As of November 2004, three of the five projects submitted for funding under the Small Business Grants Program have been awarded grants. All three of the approved applicants received funds to replace business vehicles.

TCEQ received 74 applications for FY 2004 New Technology Research and Development Program funds, of which 17 applications were approved. Funded projects include:

- 7 retrofit technologies for existing engines/vehicles
- 7 advanced technologies for new engines/vehicles (e.g., hybrid-electric, fuel cell, fuel additives)
- 1 advanced technology to reduce emissions from coal-fired power plants
- 1 study to improve air quality assessment and modeling

Discussion of Interview Findings

The TERP Program has a shorter history than the Moyer Program and received full funding only in the most recent fiscal year, so stakeholder opinions on the program are still tentative. In general, TERP is widely considered to be a success. The unprecedented amount of funding for the program in FY04 (\$142.8 million) generated considerable interest in the program in Texas and accomplished a large number of emission reduction projects. A much larger share of TERP funds has gone to construction companies than under the Moyer Program, mostly to repower off-road equipment or purchase cleaner equipment.

The TERP application process is intended to be simple, but some small companies still find the application and reporting process daunting. TERP has created a cottage industry of firms that help many companies apply for TERP funding. TERP's Small Business Program is intended to better cater to the needs of small companies, but to date it has attracted only a small number of applications.

In order to reduce the administrative burden of a grant program like TERP, some stakeholders have suggested restructuring the program so the funds are offered as standardized rebates. In this approach, the administering agency would pre-approve a set of emission reduction strategies, possibly using EPA or CARB verified technology list. The administering agency would develop a formula (web-based tool or spreadsheet) to be used by applicants to calculate the rebate amount available to them. The rebate formula would take into account the average emissions for the existing piece of equipment, the emission reduction to be achieved using the control strategy, and the cost of the technology. Equipment owners could then perform the emission reduction project (retrofit, repower, new purchase, etc.) on their own schedule and complete a rebate request form.

A standardized rebate approach would be simpler to administer and would provide more certainty to grant applicants. It would eliminate the need to submit applications. Some applicants reportedly would accept less funding in exchange for certainty that they will receive the funds. Funds would be distributed on a first-come first-served basis, so the administering agency would need to ensure that prospective applicants are informed of the funds available and do not undertake emission reduction projects expecting a rebate after the funds have been exhausted.

Another suggestion is to offer block grants that would allow someone other than the owner of the equipment to “pre-apply” for grants for certain types of activities. For example, equipment or vehicle dealers could submit a preliminary application for grants covering the purchase of qualifying equipment. Customers of such dealers would then have a streamlined process to apply for a grant when they purchase this equipment.

Some stakeholders have expressed concern about the lack of verified emission reduction technologies for off-road diesel equipment (retrofits and fuels). Some would prefer that TERP allow use of non-verified technologies when adequate verified technologies are not available for a particular application, although this might jeopardize the SIP credits that prompted the creation of TERP.

3.4 Regional and Local Grant Programs

Regional and local agencies also implement grant programs to reduce diesel emissions. Regional and local agencies generally do not have the funding resources of a state, so these programs are typically modest unless they are backed by state or federal funds. The three examples described in this section – located in the Puget Sound, Sacramento, and Gateway Cities regions (Long Beach area) – apply primarily to on-road diesel vehicles, but offer some useful lessons for diesel emission reduction grant programs in general.

As described in Section 3.2, the Moyer Program is administrated at the regional level by the California’s air quality management districts. These districts have some discretion in how they award funds, although they must comply with CARB’s general guidelines. Major regional programs are administered by the Bay Area Air Quality Management District (San Francisco region), the Sacramento Metropolitan Air Quality Management District, the San Joaquin Valley Unified Air Pollution Control District, the South Coast Air Quality Management District, and the San Diego Air Pollution Control District. Some of these districts may supplement and expand their Moyer program using other funds. Because we reviewed the Moyer Program in detail in Section 3.2, the Moyer-funded district programs are not covered in this paper.

Puget Sound Diesel Solutions Program

Developed and administered by the Puget Sound Clean Air Agency, the Diesel Solutions Program is a voluntary diesel retrofit program designed to reduce PM and other toxic emissions. The program provides grant funding to promote on-road and off-road diesel retrofits and also promotes widespread availability and use of ULSD in the four-county central Puget Sound region. The program is open to government, school, and private diesel fleets.

The program was initially funded by \$1 million in seed money from EPA and received technical guidance from EPA’s Voluntary Diesel Retrofit Program. Additional funding was provided by the Puget Sound Clean Air Agency, the Washington State Department of Ecology, and EPA Region 10. Tosco Refining produces the ULSD for the program. A challenge in the initial stages of the program was to create sufficient demand for ULSD so that suppliers would be willing to provide the fuel for the region. Three large fuel consumers agreed to participate:

1. King County METRO, which will retrofit all 1,000 METRO buses and use ULSD throughout its fleet
2. The City of Seattle, which will use ULSD and retrofit much of its diesel fleet
3. The Boeing Company, which will also retrofit its fleet and use ULSD

The State of Washington also has a state program to encourage diesel retrofits. Most of the \$5 million in funding is dedicated to school buses, but 15 percent can be used for other applications. This funding has been used to retrofit solid waste trucks in Tacoma and Seattle.

Much of the initial \$1.2 million funding from the Diesel Solutions Program has already been allocated. In 2003, 64 diesel oxidation catalysts (DOCs) and 14 diesel particulate filters (DPFs) were installed on school buses, 227 DPFs were installed on transit vehicles, and 219 DOCs and 12 DPFs were installed on other on- and off-road vehicles. In all, more than 1,000 retrofits were funded in the first two years of the program.

The Diesel Solutions Program has succeeded in promoting diesel retrofits in a large portion of the region's public sector diesel fleet, in part by engaging senior level members of the government community. Nearly all transit buses in the region have now been retrofitted, for example. The program has also succeeded in facilitating a reliable supply of ULSD to the region and helping to minimize the cost difference. The cost differential for ULSD in the Seattle region is one of the lowest in the country – typically 3 to 5 cents per gallon, down from 8 cents per gallon before the program.

The program has struggled to attract private sector interest. Very few private fleets have applied for the grant funding or even expressed interest. Staff with the Puget Sound Clean Air Agency attribute this to several factors. One is a strong concern about the effect of any change in after-treatment or fuels on engine performance or engine warranties. Many private companies view retrofits as untested technology and potentially damaging to their fleet. Another factor has been the incremental cost of ULSD. Even though the incremental cost in the Puget Sound region is as low as 3 cents per gallon, most private operators are unwilling to pay even this increment. They would need a fuel subsidy to voluntarily switch to ULSD.

Sacramento Emergency Clean Air & Transportation Program

The Sacramento Emergency Clean Air & Transportation (SECAT) program is a voluntary program that seeks public and private fleet owners to reduce NOx emissions from their on-road heavy-duty diesel engines. The program was initiated in 2000, focusing on retrofitting and repowering existing diesel engines, as well as purchasing new, cleaner vehicles. In February 2002, the program was expanded to include scrappage (“fleet modernization”).

The SECAT program was originally authorized by the California legislature in 2000 as a joint partnership between the Sacramento Metropolitan Air Quality Management District (SMAQMD) and the Sacramento Area Council of Governments (SACOG) to help the Sacramento ozone non-attainment area meet its SIP commitments. Program funds are provided to:

- Purchase new, low, or zero-emitting vehicles
- Replace older, high-emitting vehicles with new, low-emission vehicles
- Repower existing high-emitting diesel engines with new, lower emitting diesel engines
- Retrofit existing vehicles with NOx emission reduction equipment
- Purchase “cleaner” diesel fuel formulations and/or diesel emulsion fuels instead of standard diesel fuel
- Purchase other verifiable, enforceable, and cost-effective technologies for reducing NOx emissions

To reduce emissions from existing vehicles, the program originally funded repower projects only. However, repowers did not prove cost-effective and were not popular with industry. So, based on industry feedback, SECAT now emphasizes fleet modernization to maximize emission reductions while providing the greatest value to truck owners. Minimum eligibility requirements for the vehicle to be replaced and the replacement vehicles are provided in Table 3-6.

Table 3-6: SECAT Vehicle Requirements for Fleet Modernization

Vehicle to be Replaced	Replacement Vehicle
<ul style="list-style-type: none"> • HDDV >14,000 lbs. GVWR and model year 1990 or older • Owned and operated by applicant in Sacramento region since January 2001 • Must be operational at least part-time or seasonally • Must be salvaged in the same operating condition as in first inspection 	<ul style="list-style-type: none"> • Must have manufacture date of 2000 or newer • Must have same hp rating as replaced vehicle (unless otherwise approved) • Must be in same weight class and have same axle and body configuration as replaced vehicle • Must have a min. 1-yr./100,000 mile major component warranty • Must have CARB-verified PM control device if available and appropriate • SMAQMD must be listed as 1st lienholder on vehicle title

Although the program is currently designed strictly for on-road projects (due to the program's revenue from transportation funds), funds are available for more than just capital costs. SECAT funds can be used to offset the incremental costs of the purchase of cleaner technologies and fuels, as well as some associated costs, such as facility modifications, increased operating costs, and out-of-cycle vehicle replacement costs.

The SECAT program began in FY2000-2001 with \$50 million in state funding allocated for the creation and implementation of the program. SECAT secured an additional \$20 million in Congestion Mitigation and Air Quality (CMAQ) Improvement Program funds from the Federal Highway Administration (FHWA). While SMAQMD administers the program, SACOG handles the program's finances. The SECAT program received \$16 million in state funding before the California budget crisis froze distribution of the remaining funds. The remaining \$34 million is locked up in lawsuits at the state level. However, another \$3.1 million in CMAQ and matching funds will be available in early 2005.³⁵

Applications are evaluated on a first come, first served basis. NOx emission reductions and cost-effectiveness are calculated on a per-engine/vehicle and overall project basis. In order to be approved, eligible projects must meet one of the following two cost-effectiveness criteria:

1. The total requested funding amount is less than \$12,000 per ton of NOx reduced in the Sacramento region over the project's lifetime, less than \$50,000 per ton of NOx reduced annually, and does not exceed the incremental costs of the project to the applicant.
2. The total requested funding amount is less than \$6,000 per ton of NOx reduced in the Sacramento region over the project's lifetime (minimum of 5 years) and less than \$25,000 per ton of NOx reduced annually.

³⁵ Information provided by Kristian Damkier, Sacramento Metropolitan Air Quality Management District.

Criterion 1 is used to determine eligibility for 99 percent of the project applications and is designed to cover purchases, repowers/retrofits, and replacements, as well as qualifying fuels, which must meet the annual cost-per-ton cap as they can only be used once and, therefore, do not have a project lifetime. Criterion 2 applies to infrastructure and other less traditional projects. Under either criterion, SECAT funding can only be used to offset incremental project costs.^{36, 37}

The awarded funding amount equals the emission reduction benefit achieved and is capped depending on whether the replacement vehicle is new or used. For used replacement trucks, the grant amount must be less than the National Automotive Dealership Association (NADA) commercial truck guide adjusted loan value. For new replacement trucks, the grant amount cannot exceed 72 percent of the invoiced price. If neither of the cost-effectiveness criteria is met, an applicant may petition the SMAQMD for further consideration. SACOG will then approve or deny any petition accepted by SMAQMD.

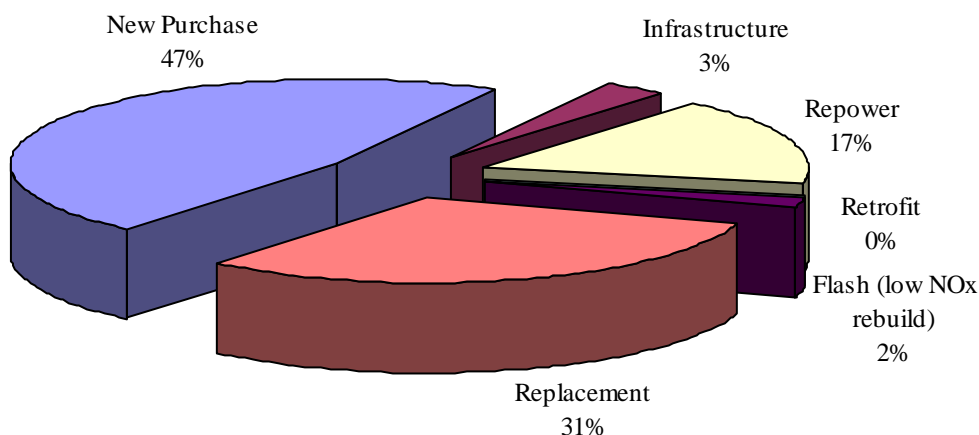
Participants must agree to several conditions regarding usage of the replacement vehicle. Usage documentation for the life of the project includes a driver's log with actual mileage, fuel consumption, and maintenance and down time records. Usage reports must be submitted at least twice annually. Projects that do not meet their performance requirements may have to refund part or all of their SECAT funding. All projects are subject to random audits to ensure compliance with program terms.

To date, the SECAT program has funded more than 1,300 projects that have resulted in more than 1.3 tons per day of NOx emission reduction from heavy-duty diesel vehicles in the Sacramento region. Figure 3-3 displays funding allocation by project type for the \$33.8 million disbursed to program participants as of December 2004.³⁸ While SECAT has historically funded mainly repowers and new purchases, fleet modernization (scrappage and replacement with a newer vehicle) has been emphasized since 2002 as the more cost-effective option for reducing emissions from existing fleets. Fleet modernization has predominately funded on-road projects for companies in the construction and agriculture industries.

³⁶ SECAT funds can be awarded more liberally than Carl Moyer and TERP funds due to the flexibility in SECAT's authorizing legislation. However, when allocating program funds, SMAQMD and SACOG try to stay within the same range as other programs.

³⁷ Information provided by Kristian Damkier, Sacramento Metropolitan Air Quality Management District.

³⁸ Based on data provided by Kristian Damkier, Sacramento Metropolitan Air Quality Management District.

Figure 3-3: SECAT Funding Allocation by Project Type

Source: Prepared by ICF Consulting based on information provided by Kristian Damkier, Sacramento Metropolitan Air Quality Management District

Gateway Cities Clean Air Program

The Gateway Cities Clean Air Program is closely modeled after the SECAT scrappage program described above. The program began operations in September 2002 and is designed to reduce diesel emissions from on-road heavy-duty vehicles in the communities surrounding the Ports of Los Angeles and Long Beach. The Gateway Cities Council of Governments (GCCOG) manages the Gateway Cities Program in partnership with the Ports. Although the program targets on-road trucks rather than off-road equipment, it was recognized by a number of interviewees as innovative and successful, so we describe it in some detail.³⁹

Under the Gateway Cities program, truck replacement candidates must meet the following qualifications:

- Replaced vehicle must be an on-road heavy-duty diesel vehicle with a GVWR of 14,000 lbs. or greater. Replaced vehicle must be model year 1983 or older, and the engine must be model year 1990 or older (i.e., the vehicle to be scrapped may have been repowered with a newer engine).
- Vehicle owner must have owned and operated the vehicle to be replaced for the previous two years.
- Vehicle to be replaced must be in operating condition and be roadworthy, as confirmed by passing the California Highway Patrol's Biennial Inspection of Terminals or the program's Vehicle Inspection.
- Within the last two years, 85 percent of the miles driven by the vehicle to be replaced must have been within the South Coast Air Basin. Priority may be given to vehicles that work predominantly in the Port area and in the Gateway Cities region.
- Vehicle to be replaced must be currently insured and registered according to state requirements.

³⁹ Note that the Gateway Cities Clean Air Program also has a non-road grant program targeting cargo handling equipment at the Port of Long Beach. We describe this program under the Port of Long Beach sub-section below.

The replaced vehicle must be salvaged at a participating salvage yard within 60 days of turning the vehicle in. To prevent resale and continued use of the replaced vehicle, the salvage yard must destroy the engine block and the frame rails of the truck, and photographs and a completed and signed “Certificate of Vehicle Destruction” must be submitted to GCCOG.

The replacement truck must be comparable in horsepower rating, body style, and commercial use to the one being replaced. After the replacement has been funded, the owner/operator of the replaced vehicle must:

- Operate the replaced vehicle in the South Coast Air Basin for at least 5 years
- Continue to operate the replaced vehicle in contracted vocation(s), as specified in the application, a minimum of 85 percent of the miles
- Apply two GCCOG decals to the replaced vehicle to promote the program
- Not exceed an increase of 1.3 times the base mileage specified in the application; the owner/operator must provide quarterly statements of mileage accumulated within the South Coast Air Basin and mileage accumulated outside of the area⁴⁰
- Provide proof of minimum insurance requirements and registration once a year

A total of \$16.1 million in funding for the Gateway Cities Program has been provided by the three original contributors – EPA, CARB, and the Port of Long Beach – and more recently, by the Port of Los Angeles and the South Coast Air Quality Management District (SCAQMD). In 2003, the Port of Los Angeles committed \$10 million to the program as part of the China Shipping terminal settlement. Replacements funded by the Port of Los Angeles must be for trucks that have made at least 100 deliveries to or from the Port in the 12 months prior to submitting an application.

Program funding is awarded based on cost-effectiveness as detailed in Table 3-7.

Table 3-7: Gateway Cities Program Cost-Effectiveness Thresholds

Model Year of Replaced Vehicle	Engine in Replacement Vehicle	Model Year of Replacement Engine	Cost-Effectiveness (\$/1-year ton NOx)
Pre-1977	Original Engine	1994 or newer ^a	\$20,000
	Repowered with new engine	Latest available new engine ^b	\$35,000
1977-1983	Original engine	1994 or newer ^a	\$50,000
	Repowered with new engine	Latest available new engine ^b	\$50,000

Note a: 1998 model year engines are not allowed to receive program funds unless the engine emission performance is recalibrated to meet or be less than 1999 model year emissions standards.

Note b: Requires repower of original replacement vehicle engine with a latest model engine certified by CARB to 4.0 or 2.5 grams per horsepower-hour or rebuild.

As of June 2003, 86 grants had been awarded for a total of \$2.1 million, resulting in an estimated reduction of 339 tons and 86 tons of NOx and PM emissions, respectively, over the next five years. The average incentive amount has been approximately \$24,500, based on the initial 86 awards made in the

⁴⁰ Based on program experience, showing proof of mileage has proven problematic for many participants. The program will accept one of the following as proof: 1) Federal Tax Form – Schedule C (fuel line item), 2) maintenance records, 3) Biennial Inspection of Terminals inspection report, or 4) fuel receipts.

first seven months of program operation (September 2002 to June 2003). In addition, the Gateway Cities program estimates that awardees gain fuel savings of \$1,700 annually per replaced truck. The cost-effectiveness of the 86 awards was estimated at \$7,208 per ton of NOx reduced and \$31,298 per ton of PM reduced.

While the program experienced initially heavy administrative costs and again incurred additional management expenses when CARB provided funding and requested some guideline changes, the current distribution of funds is approximately 85 percent to incentive awards and 15 percent to program administration and monitoring of program effectiveness. There have been some cash flow impedances due to the number of agencies providing funding, and GCCOG suggests requiring a minimum funding amount be consistently maintained so that the number of awards granted does not exceed the current program funding balance.

Paperwork, at least for application to and verification of replacement for the fleet modernization component of the program, is fairly demanding. The largest delay for the program has been the review to time to complete and process each application. GCCOG reports that the amount of time required to process each application is determined by its ability to obtain the required paperwork and documentation, the accessibility to the applicant, and the effort and availability of the dealer involved. Therefore, processing time can range from less than a day for fully complete applications to months when applications are incomplete or not verifiable. In order to speed the process, the program has placed responsibility on the participating dealerships to ensure that the applicants fill out the necessary forms accurately and completely. In addition, GCCOG suggests a more concise application that has a clear checklist of items to be submitted and relevant examples of what is acceptable. They also suggest clearly delineating which information can be filled out by the dealer on behalf of the applicant and which information needs to be completed by the applicant. As previously mentioned, the most difficult reporting requirement has been verifying mileage driven inside and outside of the South Coast Air Basin. In addition to providing concrete examples of acceptable proof of mileage, GCCOG suggests developing a mileage worksheet to further aid applicants in estimating their annual mileage.

3.5 Port Administered Grant Programs

A number of ports administer grant programs that provide diesel retrofit funding for the port's tenants. These programs may be funded entirely by the port or the program may be funded in whole or in part by state or federal agencies. The three major port grant programs are all in California: the Port of Oakland, the Port of Los Angeles, and the Port of Long Beach. Both the Port of Oakland and Port of Los Angeles programs were initiated in response to legal settlements.

Port of Oakland

The Port of Oakland was the first in the nation to develop a major grant program focused on diesel emission reductions. Community groups sued the Port in 1997 over the Vision 2000 expansion program, which would increase the number of trucks, cargo handling equipment, and ships operating at the Port. As part of the settlement agreement, the Port established an Air Quality Mitigation Program, which includes grants to reduce both on-road and off-road diesel emissions at the Port.

The terminal equipment component of the program offers grants to terminal operators to retrofit and repower cargo handling equipment. The Port has provided \$4.5 million to fund the program. The Port first performed a detailed inventory of equipment in use, including age and hours of operation. The Port then met with terminal operators to develop a menu of emission reduction options for each equipment type. Participating terminal operators are responsible for performing the retrofits and invoicing the Port for reimbursement. The Port estimates that the program will reach approximately 80 percent of the eligible

equipment by the time it concludes. The program is installing 151 diesel oxidation catalysts and 159 diesel particulate filters, plus half of the marine terminal operators are now using ULSD.

Port of Oakland staff have described overcoming several challenges in implementing the program. The biggest challenge involves carefully structuring the program to maximize emission reductions with the available funding. The incentives must be large enough to encourage terminal operators to take them, but providing too high an incentive will deplete available funding before the target penetration levels have been achieved.

Securing participation by terminal operators can also be challenging. At the Port of Oakland, some operators were more eager to participate than others, due in part to corporate commitment to environmental stewardship. Most operators eventually agreed to take advantage of the funding because it appears that CARB may mandate retrofits of off-road diesel equipment in the future.

The on-road truck portion of the Air Quality Mitigation Program will offer grants to retrofit, repower, and replace trucks serving the Port. The Port has provided \$1.5 million toward this program, with another \$1.5 million coming from the Moyer Program. Incentive funding can be used in three ways:

1. Retrofit trucks with DOCs and particulate filters
2. Replace truck engines (repowering)
3. Purchase model year 1996 or newer trucks and scrap older ones

Port staff are currently working on the truck replacement guidelines and applications.⁴¹ They expect that incentives of up to \$15,000 will soon be available to replace old trucks with newer trucks. The most challenging part of the program has been identifying and contacting the truck owners and operators. Many are self-employed truck drivers. Like the off-road program, another challenge has been to establish incentive levels that ensure adequate participation but maximize cost-effectiveness.

Port of Los Angeles

The Port of Los Angeles has implemented several grant programs in recent years that promote diesel emission reductions. The most significant is the Air Quality Mitigation Program established as part of the China Shipping terminal settlement agreement. A coalition of environmental groups, including the Natural Resources Defense Council and the Coalition for Clean Air, sued the Port alleging deficiencies in the Environmental Impact Report/Environmental Impact Statement prepared for the expansion of the China Shipping container terminal. Under the terms of the settlement agreement reached March 5, 2003, the Port agreed to provide \$50 million to mitigate the impact of port operations on surrounding communities. Of this amount, \$20 million is dedicated to reducing the air quality impacts of port operations, with a focus on PM reductions.

The Port's Air Quality Mitigation Program offered \$4.5 million in 2004 and will offer the remaining \$15.5 million over the next three years. Eligible projects include:

- Stationary source projects
- On-road heavy-duty vehicle projects
- Off-road heavy-duty equipment and engines including specialty port equipment
- Locomotives that regularly serve the Port

⁴¹ For current information, see http://www.portfoakland.com/enviro/m/prog_06.asp

- Alternative fuel infrastructure
- Improved diesel strategies

Only equipment owners can apply for funds (i.e., third-party applicants are not allowed). Criteria used to evaluate project proposals include the following (in descending order of importance):

- PM reduction cost-effectiveness (PM reduction projects must provide a minimum of 20 percent reduction in PM emissions)
- Degree of technology maturity
- Geographic impact
- NOx reduction cost-effectiveness (NOx reduction projects must provide measurable PM reductions, as well as 30 percent NOx reduction for new vehicle or new equipment projects or 15 percent NOx reduction for repower or retrofit projects)

Grant recipients are required to file periodic progress reports so that the Port can assess emission reductions. Typically, recipients will complete quarterly progress reports until the project is implemented, then annual progress reports are submitted.

For the first funding cycle (\$4.5 million), the Port received nearly twice the project applications that could be funded. As of December 2004, the Technical Advisory Committee had recommended projects for approval by the Port's Community Advisory Committee and Board of Commissioners. Projects on this list would perform 32 marine vessel repowers (main and auxiliary engines) and 148 off-road terminal equipment repowers, achieving an annual emission reduction of 14.5 tons of PM and 233 tons of NOx.

In addition to the Air Quality Mitigation Program, the Port has been funding the installation of diesel oxidation catalysts since May 2003. The Port plans to install nearly 600 diesel oxidation catalysts on cargo handling equipment at container terminals, including yard tractors, side and top picks, forklifts and transtainers. The Port has also been pursuing use of emulsified fuels, which optimize the reduction in PM and NOx when using a diesel oxidation catalyst. Finally, the Port approved in October 2002 a \$2.8 million investment program for terminal and ship operations targeted at reducing diesel emissions.

Port of Long Beach

The Port of Long Beach's Diesel Emission Reduction Program encourages the retrofit of diesel terminal equipment with DOCs and the use of emulsified diesel. The retrofit portion of this program is actually part of the Gateway Cities Clean Air Program described in Section 3.4. EPA and CARB provided \$1 million in funding, which the Port matched with its own funds. These \$2 million were used to fund retrofits of diesel terminal equipment with DOCs. In addition, the Port is funding the incremental cost of emulsified diesel and oxydiesel for one year at a cost estimated to be several hundred thousand dollars.

Installation of the DOCs was done by the terminal operators themselves. The DOC manufacturer visited the Port to help develop DOCs that could be bolted on to the various types of terminal equipment. The manufacturer also provided installation training to the terminal operators. The operators purchased the DOCs and sent an invoice to the Port for their equipment and labor costs. All participating operators were required to formally apply to the Gateway Cities Clean Air Program and to sign contracts stipulating the terms and conditions of the program (including liability issues and length of equipment use).

The program has been highly successful. All the terminals operators except one have participated in the program, retrofitting virtually all of their yard hostlers, top picks, and side picks. In total, approximately

600 DOCs have been installed and 160 equipment pieces are running on alternative fuels through the program.

Although nearly all terminal operators eventually joined in the Port of Long Beach retrofit program, some participated more readily than others. Staff at the Port of Long Beach have noted that several factors ultimately encouraged participation:

- Some operators are hoping to establish good relations with the Port in view of upcoming lease negotiations.
- Some operators have corporate commitments to environmental stewardship and recognized this program as an inexpensive way to help meet these commitments.
- Other operators were coaxed into participation because of fear that CARB would soon require the retrofits.

3.6 Summary of Findings on Grant Programs

Based on the interviews conducted for this study, ports, marine terminal operators, and construction companies appear to prefer grants to any other type of emission reduction incentive. All the technology options for reducing off-road emissions require a monetary investment, and while some strategies improve efficiency and reduce operating costs, these savings typically do not cover the initial investment. Marine shipping and construction are both highly competitive industries, and few entities are able to shoulder the additional expense of emission reduction technologies without some compensation. Most grant programs provide equipment owners with the flexibility they need to make their own decisions about how to reduce emissions in a cost-effective, practical manner.

Some interviewees emphasized the need for the federal government to make available diesel emission reduction grants throughout the country, not just in non-attainment areas or areas of greatest use. Many areas that meet national air quality standards are still struggling to reduce emissions of particulate matter and other air toxics, particularly when sensitive populations are concentrated near large sources of these emissions. Grants are also viewed as the only practical option to achieve significant reductions of in-use diesel emissions in areas of the country that do not believe they are able to stipulate emission reductions as part of a public works contract or a marine terminal lease (discussed in Section 5).

Environmental groups suggest that, because grant funds will never be sufficient to cover every existing off-road diesel engine, the allocation of grants should be based primarily on the environmental and public health benefits that will be achieved by a project. One option would be to require that grants be used either in nonattainment areas *or* in areas of greatest use (including diesel emission “hot spots”). This would allow a national grant program to reach all 50 states, while ensuring that funds are used most effectively.

Many interviewees echoed the need for a grant program to offer flexibility, rather than promote a particular technology or focus on a particular type of equipment. There is no one-size-fits-all solution to reducing diesel emissions. The proper strategy depends on many factors, including the remaining useful life of a piece of equipment, its salvage value, annual hours of operation, operating environment, operating costs, as well as the available options for emission reductions. Grant programs work best when they allow equipment owners to make their own decisions about methods for achieving emission reductions.

Grant programs require considerable government time and resources to administer. Agencies need to design a program that is equitable (treats different types and sizes of businesses fairly) and cost-effective

(maximizing emission reductions with the available funds). They need to promote the program to attract sufficient applications, then evaluate applications and make awards. Finally, they need to monitor use of the grant funds and ensure that recipients are complying with the program's conditions concerning equipment use.

When designing a grant program, it is important to consider the unique needs of small businesses. Restrictions on equipment use or a lengthy application process, for example, can burden a small construction company more than a large one. Public agencies should keep in mind that many small businesses may find the grant application and award monitoring process onerous and may need assistance in completing the application.

Some stakeholders have suggested that grant programs should be structured so the funds are offered as standardized rebates. Equipment owners would use a formula to determine if they are eligible for a rebate, selecting from a menu of pre-approved emission reduction strategies. Eligible equipment owners could then perform emission reduction projects and complete a rebate request form, rather than submit a grant application with uncertain results. Funds would be distributed on a first-come first-served basis. This approach would reduce the administrative burden of a grant program and provide more certainty to grant applicants.

Using emission reduction cost-effectiveness as a criterion to select grant recipients can help to maximize emission reductions with the available funding. Other selection criteria should also be considered, including nonattainment status, equity issues, and population exposure information. When a grant program is structured to provide funding for specific improvements targeted at specific applications, it is very important that the incentive level be set properly. Otherwise, available funding will be consumed without reaching all the equipment that could be reached.

The Moyer and TERP programs are highly successful, and deserve replication in other states. They are, however, expensive and unlikely to be a high priority in many states experiencing budget shortfalls. Moreover, some states do not have the option of funding a grant program using surcharges or fees on the sale, titling, or registration of motor vehicles, the source for some TERP funds. Twenty-three states require motor fuel and vehicle taxes to be spent solely on transportation projects and initiatives.⁴²

⁴² *AASHTO Journal*, November 5, 2004, p.3. Missouri voters approved such a constitutional amendment in November 2004.

4 TAX INCENTIVES

Governments at all levels use tax incentives to influence the behavior of individuals and corporate entities. By reducing or eliminating taxes on certain items or activities, governments reduce the cost of those items or activities. Several states (including Georgia and Oregon) have enacted tax incentives intended to spur the retrofit or repowering of diesel engines (both on-road and off-road). Most tax incentives fall into three general categories:

- Tax exemptions
- Tax deductions (including accelerated depreciation)
- Tax credits

A **tax exemption** is the clearest example of a tax incentive. It excludes a class of items or activities from being subject to a particular tax.

A **tax deduction** allows a taxpayer to reduce taxable income for certain expenses. For example, for federal income tax purposes, homeowners are allowed to deduct payments of mortgage interest when calculating their taxable income.

Businesses are allowed to deduct the depreciation of business assets. Different classes of business assets can be depreciated over different periods of time. **Accelerated depreciation** allows businesses to depreciate certain business assets over a shorter period of time than normally allowed by law. Compared to a firm's tax liability under a normal depreciation schedule, accelerated depreciation decreases a firm's tax liability in the near term but increases it in later years. For example, if a business is allowed to depreciate a piece of equipment over five years instead of ten years, its tax liability will be lower in the first five years but higher in the second five years. Despite the fact that accelerated depreciation merely shifts tax liabilities in time, firms typically prefer to reduce their tax liability in the near term.

A **tax credit** is a reduction in tax liability for specific expenses. Unlike deductions, which reduce taxable income, a tax credit reduces tax liability dollar for dollar. A tax credit can be structured so that it can be

Key Findings on Tax Incentives

1. *There has been scant experience with tax incentives as a means to encourage off-road diesel emission reductions. The two state tax incentives in place for diesel emission reductions (in Georgia and Oregon) have not been used, primarily because the incentives appear to be too small. Many states offer small tax incentives for the purchase of alternative fuel vehicles or alternative fuels, but these appear to have had little effect.*
2. *Tax incentives offer several advantages relative to grants. From a recipient's perspective, one advantage is that a tax incentive has no application deadline. Also, tax incentives are available to all who qualify, not just those who apply first or whose projects are the most cost-effective.*
3. *A disadvantage of tax incentives is that, unless the incentive is crafted very narrowly, the government will pay (through foregone tax revenues) for emission reductions in low-priority areas. With tax incentives, it is more difficult for the government to direct resources at the diesel emissions of greatest concern.*
4. *To be effective, tax incentives must be set high enough to induce firms to make improvements to their diesel equipment that they otherwise would not do. If the incentive is not sufficiently lucrative, it causes no change in firm behavior and may become merely a windfall for companies that would have made improvements to their equipment anyway. In addition, to take advantage of a tax incentive, companies must commit their own funds and then wait to get "paid back" through a lower tax bill. The tax incentive must be high enough to encourage firms to commit funds, even temporarily, to reducing diesel emissions.*
5. *Most tax credits, which directly reduce tax liability, are of little use to an unprofitable company or a public entity that does not pay taxes. However, tax credits can be structured with a "pass through" feature that makes them useful for low tax liability parties.*

used over more than one tax year if the value of the credit exceeds a taxpayer's tax liability in the first year.

4.1 Oregon's Pollution Control Tax Credit Program

Oregon offers tax credits for pollution control investments, including those made to non-point sources, such as diesel engines. Oregon taxpayers who install pollution control equipment on in-service diesel engines (both on-road and off-road) are eligible for an income tax credit of up to 35 percent of the cost of purchasing and installing the equipment. To receive the full credit, the equipment must be used in Oregon at all times; otherwise, the amount of credit is determined by the proportion of time the equipment is used in Oregon. The tax credit can be taken in addition to tax deductions.

Pollution control devices on EPA's Verified Technology List are automatically eligible. Owners of devices not on EPA's list may submit a pre-application prior to installation to be reviewed for eligibility. In approving the credits, the Oregon Department of Environmental Quality (DEQ) does not use an emission reduction target or cost-effectiveness threshold, but the agency will review the application to ensure that emission reductions will result. Fuel and fuel additives that may be required for use with the retrofitted equipment are not eligible for the tax credit.

Applicants have one year after the retrofit installation date to file an application with the Oregon DEQ. Applicants must verify retrofit costs in writing, provide vehicle identification numbers showing ownership, submit documentation that the retrofit device is certified by EPA, and indicate the proportion of time the vehicle operates in Oregon. Applicants are subject to an application fee equal to one percent of the total cost of the retrofit project. The credit may be used in a single year or extended over up to three years if there is insufficient tax liability.

Emission controls for diesel engines became eligible for the tax credit in January 2000. Although the Oregon DEQ, EPA, and Oregon trucking associations have actively promoted diesel retrofits, there have not yet been any applications for the tax credit. Part of the reason may be that the tax credit rate is not large enough to attract business interest. The credit was reduced from 50 percent to 35 percent in January 2002.

Oregon's pollution tax credit will not be of use to entities with no tax liability (such as public entities or unprofitable businesses). However, another tax credit program in Oregon has a "pass through" feature that makes the credit useful to low liability parties. The Business Energy Tax Credit can be passed through to a third party (such as corporation or bank) who then reimburses the original recipient of the credit for its value. This feature can be used to make any tax credit program more useful for public entities and low profit businesses.

4.2 Georgia's Tax Credit for Idling-Reduction Equipment

Georgia offers an income-tax credit of 10 percent of the cost (up to \$2,500) of diesel particulate emission reduction equipment at truck stops, depots, or other facilities. Eligible equipment must meet the Georgia Regional Transportation Authority's emissions standards and provide heat, air conditioning, light, and communications for the driver's cab in a way that does not require the operation of the vehicle engine. The credit is based on the total cost of purchase and installation of the equipment. The program was initiated in 2000, but no one has yet applied for the credit. (A bill was introduced in the U.S. Congress in April 2004 to provide a business tax credit for 50 percent of the cost of a qualifying truck idling reduction device, up to \$3,500. The bill was not passed, however.)

4.3 Simplified Tax Refund Process for On-Road Diesel Used in Off-Road Equipment

One option for reducing emissions from off-road diesel equipment is to use on-road diesel fuel instead of off-road diesel. Diesel fuel sold for use in most off-road applications, such as construction equipment, has a sulfur content of around 3,300 ppm. The current standard for fuel used in highway diesel engines limits sulfur concentrations to a maximum of 500 ppm, and this limit will drop to 15 ppm in 2006.

The price of gasoline and diesel at the roadside service station includes an average of 19 cents per gallon in state excise taxes.⁴³ These excise taxes are considered a type of user fee for the highway system, and the proceeds are largely dedicated to construction and maintenance of a state's transportation infrastructure. In many states, consumers who purchase highway fuel for use in off-road equipment are eligible to receive a refund of these excise taxes.⁴⁴ However, the process for obtaining the refund can be burdensome. One policy option for encouraging use of highway diesel in off-road equipment is to simplify or expedite this refund. According to the Puget Sound Clean Air Agency, the state of Washington has simplified its process for getting this type of tax rebate.

4.4 Tax Deduction Proposed by the Associated General Contractors of America

The Associated General Contractors of America (AGC) is in favor of amending the federal income tax code to allow firms to immediately write off or expense the cost of purchasing and installing diesel retrofit equipment. Under current federal law, firms depreciate the cost of this type of equipment over several years.

AGC's proposed tax deduction would reduce the amount of taxable income that firms would show in the year that they purchase and install retrofit equipment. AGC prefers a tax deduction to a tax credit, because a tax deduction reduces taxable income and, therefore, does not discriminate among the different ownership structures of firms, which are subject to different income tax rates. For example, a \$100 tax deduction for a taxpayer with a marginal tax rate of 35 percent saves him/her \$35 in tax liability. The same tax deduction for a taxpayer facing a marginal rate of 40 percent reduces tax liability by \$40. In both cases, the tax savings as a percentage of total tax liability is the same.

In contrast, a tax credit would reduce tax liability directly, so the value of the benefit depends on the tax rate that is applicable to each taxpayer. For example, a tax credit of \$100 is equivalent to a tax deduction of \$250 for a taxpayer in a 40 percent tax bracket ($0.40 \times \$250 = \100). For a taxpayer in a 35 percent tax bracket, the same \$100 tax credit is equivalent to a tax deduction of \$286 ($0.35 \times \$286 = \100).

An advantage of creating a tax incentive at the federal level is that the federal income tax rates are higher than state tax rates. Therefore, a federal income tax incentive is more valuable to a company than a state income tax incentive. A federal tax incentive is also more appealing to firms that use the same equipment in multiple states, because state tax incentives usually require the retrofitted equipment to be used predominantly in the state providing the tax incentive.

4.5 Federal Excise Tax Credit for Biodiesel

Biodiesel is made from soybeans and other natural fats and oils. It can be used in diesel engines in its pure form, but it is most commonly blended with petroleum diesel to make a mix of 80 percent diesel and 20

⁴³ Federal Highway Administration, *Highway Statistics 2003*, Table MF 205.

⁴⁴ Federal Highway Administration, *Exemption And Refund Provisions Of State Gasoline Taxation*, 2001.

percent biodiesel (B-20). Biodiesel can be used in diesel engines with few or no engine modifications, and it can significantly reduce emissions of CO, PM, unburned HC, and sulfates.

In October 2004, President Bush signed the American Jobs Creation Act of 2004, which among other tax provisions included a federal excise-tax credit for biodiesel. The goal of this tax credit is to make the price of biodiesel more competitive with petroleum-based diesel. The tax credit amounts to one penny per percent of biodiesel in a fuel blend made from first-use oils and one-half penny per percent for recycled oils. For the common B-20 blend, this tax credit amounts to 20 cents per gallon (assuming the biodiesel is made with first-use oils). The tax credit takes effect on January 1, 2005, and lasts for two years.

The tax credit is available to petroleum distributors, who in theory will be driven by competitive forces to pass the tax savings on to the consumer, regardless of whether the consumer pays taxes. In this way, proponents hope that the price of biodiesel will drop both for private consumers and tax-exempt customers, such as school districts, that purchase fuel for school buses.

4.6 State Alternative Fuels Tax Incentives

Most states offer tax incentives to promote the purchase or lease of alternative fuel vehicles (AFVs) or the conversion of conventional vehicles to use alternative fuels. Some states also offer tax incentives to help offset the cost of purchasing alternative fuels. Tables 4-1 and 4-2 summarize current incentive programs and identify states known to offer them. While most of the incentives are intended for on-road vehicles, some of the incentives apply to both on- and off-road vehicles. The tables were compiled based on information provided by the U.S. Department of Energy's Clean Cities Program through the Alternative Fuels Data Center.⁴⁵

Table 4-1: State Tax Incentives for the Purchase or Lease of Alternative Fuel Vehicles

Incentive Type	States
Individual Income Tax Credit or Deduction	CO, GA, KS, LA, MT, NY, OK, OR, RI, UT, WI, WV
Corporate Tax Credit	CT, MT, OR, UT, VT
Retail Sales Tax Reduction or Exemption	CO, CT, ME, NY
License Fee Reduction	AZ
Grants or Rebates to Individuals	AR, CA, IL, PA
Grants or Rebates to Local Governments (including school districts)	AR, CA, DC, GA, IL, IN, MD, NC, NJ, NY, TX, UT, WV
Grants or Rebates to Businesses	CA, DC, GA, IL, IN, MD, NC, NY, PA, TX, UT
Low Interest Loans to Individuals	NE
Low Interest Loans to Local Governments	NE, OK, RI
Low Interest Loans to State Agencies	RI
Low Interest Loans to Businesses	NE, OK

⁴⁵ See http://www.eere.energy.gov/cleancities/incen_laws.html. The incentives are current as of December 2004; however, the tables should not be considered an exhaustive list of all state tax incentives available.

Table 4-2: Examples of State Tax Incentives for the Purchase of Alternative Fuels

Incentive Type	States
Individual Income Tax Credit	ME (production of biodiesel)
Retail Sales Tax Reduction or Exemption	HI (alcohol fuels), IA (ethanol, natural gas), ID (ethanol, biodiesel), IL (ethanol, biodiesel)
Grants or Rebates to Individuals	IL (ethanol, biodiesel)
Grants or Rebates to Local Governments (including school districts)	IL (ethanol, biodiesel), IN (ethanol, biodiesel)
Grants or Rebates to Businesses	IL (ethanol, biodiesel), IN (ethanol, biodiesel)

Most of the state incentives for AFVs or alternative fuels have not had a significant impact.⁴⁶ This is often because the incentives are not large enough to entice consumers to buy an AFV or alternative fuels, or because the incentive program is difficult for consumers to use. Promoting alternative fuel use also depends on an adequate fuel supply and fueling infrastructure, something that many regions lack.

4.7 Summary of Findings on Tax Incentives

There has been scant experience with tax incentives as a means to encourage off-road diesel emission reductions. The two state tax credits in place for diesel emission reductions have not been used. Many states offer small tax incentives for the purchase of AFVs or alternative fuels, but these appear to have had little effect. In general, diesel equipment owners find that tax incentives are too small to induce a change in their behavior. However, terminal operators and construction industry stakeholders have expressed strong interest in the concept of tax incentives as a way to promote diesel emission reduction strategies.

Tax incentives offer both advantages and disadvantages relative to grants. From a recipient's perspective, one advantage of a tax incentive is that it has no application deadline. After the incentive is in place, eligible firms can apply for it on their own schedule, without fear that incentive funds will be exhausted. Private sector interviewees noted that they sometimes have difficulty applying for grants because an application schedule may not fit well with their business schedule. Also, tax incentives are available to all who qualify, not just those who apply first or whose projects are the most cost-effective.

A disadvantage of tax incentives is that unless the incentive is crafted very narrowly, the government will pay (through foregone tax revenues) for emission reductions in low-priority areas. With tax incentives, it is more difficult for the government to direct resources at the diesel emissions of greatest concern.

Dollar for dollar, a tax credit (which reduces tax liability) is more valuable than a tax deduction (which reduces taxable income). A traditional tax credit may not be useful to a company operating at a loss or barely getting by. It helps if the tax credit can be carried forward to future years, but ultimately it will not be useful if the firm has little or no taxable income over a number of years. Similarly, publicly owned port authorities that pay no taxes will not benefit from a traditional tax credit. However, tax credits can be structured with a "pass through" feature that makes them valuable to parties with low tax liability. The

⁴⁶ National Conference of State Legislatures, *State Alternative Fuel Vehicle Incentives: A Decade and More of Lessons Learned*, February 2001.

credit is passed to a third party, who then reimburses the original recipient of the credit. Oregon's Business Energy Tax Credit has this feature.

AGC prefers a tax deduction to a tax credit, because a tax deduction reduces taxable income and, therefore, does not discriminate among the different ownership structures of firms, which are subject to different income tax rates. Tax incentives are more attractive if they allow a tax credit in addition to a tax deduction. Oregon's pollution control tax credit, for example, can be taken in combination with a tax deduction.

To be effective, tax incentives must be set high enough to induce firms to make improvements to their diesel equipment that they otherwise would not do. If the incentive is not sufficiently lucrative, it causes no change in firm behavior and may become merely a windfall for companies that would have made improvements to their equipment anyway. Both the Georgia and Oregon tax credits appear to be too small to encourage firms to use them. In addition, to take advantage of a tax incentive, companies must commit their own funds and then wait to get "paid back" through a lower tax bill. The tax incentive must be high enough to encourage firms to commit funds, even temporarily, to reducing diesel emissions.

In general, construction companies and marine terminal operators have noted that they do not expect to see any efficiency gains from the retrofit of diesel equipment or use of alternative fuels. In other words, they do not expect to receive a financial return on their investment in this equipment. Given this perception, these companies might not be motivated by a tax incentive of less than 100 percent.

When developing new tax incentives, it is important to consider how this tax benefit could complement other types of incentives. For example, a tax incentive paired with a statewide or regional contract specification (discussed in Section 5) could provide both a "carrot" and a "stick" to the construction industry in a particular region.

5 MODIFIED CONTRACTING PROCEDURES

Generally, the Clean Air Act prohibits state and local governments from setting their own emission standards for either new or in-use engines, except for California and any other state standards that identically follow California's lead. Nevertheless, some states have added provisions to their construction contracts requiring or encouraging the use of cleaner equipment or the retrofitting or repowering of older equipment. Similarly, ports can add requirements to leases with marine terminal operators regarding the diesel equipment used at the terminal and other types of environmental performance. Because companies enter into these contracts and leases voluntarily, the diesel-related requirements do not appear to violate the Clean Air Act, although there is some legal ambiguity in this regard. Contract and lease procedures that *require* diesel emission reductions are more akin to state or local regulations than to incentive programs per se; we discuss them in this report because they are similar to some voluntary contract incentives and because they can easily be implemented in conjunction with voluntary programs.

Contract provisions for construction projects can take a number of forms:

- A contract specification requires the contractor to adhere to specific requirements during completion of the contract. The contractor is expected to build the additional cost of meeting those requirements into the firm's bid.
- A contract preference gives a contractor bonus points during the evaluation of bids if the contractor commits to using cleaner diesel equipment for the job.
- A contract allowance is a pool of money that is made available to the winning bidder to retrofit or repower the firm's equipment for use on the job.

Key Findings on Modified Contracting Procedures

1. *Contract specifications, which require emission reduction technologies as part of a construction contract, appear to be growing in popularity following several high profile examples: Massachusetts' Big Dig and Connecticut's Q Bridge I-95 project. The nation's most extensive effort to use contract specifications for diesel retrofits is occurring in New York City, where Local Law No. 77 will soon require use of ULSD and "best available technology" for emission control in all diesel-powered off-road equipment used in city construction projects. Contract specifications are strongly supported by the environmental community.*
2. *When implementing contract specifications, agencies should engage the contracting community to ensure that companies are aware of the future requirements and have time to prepare for them. The provisions should be written as performance requirements so that they do not discourage the development and use of new technologies. And contract provisions should contain exemptions for equipment for which there is no effective retrofit technology or clean fuel.*
3. *The proliferation of contract specifications is a major concern to the contracting community for several reasons. Small contracting companies may not have the ability to finance the equipment upgrades necessary to win work under a contract specification. If implemented widely in a particular region, contract specifications could shrink the market for a construction company and devalue its assets.*
4. *A contract allowance incorporates a payment to the contractor to offset, fully or partially, the cost of emission reduction investments. When paired with contract specifications, contract allowances may provide a mechanism to help level the playing field for small contractors who cannot finance investments in emission reduction technologies.*
5. *Lease specifications can allow a port to stipulate a variety of emission reduction measures at marine terminals, for both vessels and cargo handling equipment. The Port of Los Angeles is currently requiring a number of emission reduction measures as part of a new terminal lease. This mechanism appears unlikely to spread widely outside Southern California in the near term, because most ports are hesitant to stipulate diesel emission reductions in a lease for fear it would harm their competitive position.*

This section describes these three contractor provisions and port lease specifications.

5.1 Contract Specifications

Several state departments of transportation have begun using contract specifications in their contracts for construction projects. New York City has gone so far as to incorporate requirements for off-road diesel emission reductions into all of its public works contracts. Specific examples of contract specifications are described below, followed by a discussion of potential benefits and concerns raised by interviewed stakeholders.

Massachusetts Clean Air Construction Initiative

The Massachusetts Central Artery/Tunnel project, commonly known as the Big Dig, included one of the first and best known examples of contract specifications for diesel retrofits. The Clean Air Construction Initiative was created as a way to show that emission control equipment for on-road engines could be effectively applied to off-road equipment. In September 1998, the Massachusetts Turnpike Authority (MTA), partnered with the Massachusetts Department of Environmental Protection (MA DEP) and Northeast States for Coordinated Air Use Management (NESCAUM) to implement a two-phased pilot project to retrofit construction equipment with DOCs.⁴⁷ The Manufacturers of Emissions Control Association (MECA) donated DOCs for the first phase of the program, which targeted equipment used near hospitals, residences, and schools. The first phase was successful in demonstrating that the DOCs could be installed in an acceptable timeframe (two hours). The second phase of the pilot was implemented in locations similar to those targeted during the first phase, while also targeting equipment that would remain at the work site for the longest duration.

The success of the initial pilot program in significantly reducing diesel emissions (as monitored by NESCAUM) led to the adoption of a contract requirement that all remaining contractor-owned diesel equipment be retrofitted with DOCs for the life of the Big Dig project. The retrofit requirement is contained within the odor control section of such contracts. As part of the Construction Odor Control Specification, contractors must meet the following additional requirements:

- Keep equipment properly tuned
- Turn off diesel engines on construction equipment when not in active use and on dump trucks that are idling while waiting to load or unload material for five minutes or more
- Establish a staging zone for trucks that are waiting to load or unload material at the work zone in a location where diesel emissions from the trucks will not be noticeable to the public
- Locate construction equipment away from sensitive receptors, such as fresh air intakes to buildings, air conditioners, and windows

Well over 100 pieces of construction equipment have been retrofitted with DOCs. The resulting emission reductions are estimated at 36 tons of CO, 12 tons of HC, and 3 tons of fine PM per year. Further emission reductions have been achieved from all on-site equipment voluntarily using on-road diesel instead of off-road diesel. In addition, the project tested Lubrizol's PuriNOxTM in operation. While emission reductions were significant and only minor operational complaints arose, its use has never been contractually required.

⁴⁷ Other project sponsors include the Massachusetts Highway Department (MassHighway), Massachusetts Executive Office of Environmental Affairs (MA EOE), and EPA Region 1. In addition, the Federal Highway Administration (FHWA) has oversight authority for the Big Dig project overall to ensure that public tax dollars are spent responsibly.

Connecticut Clean Air Construction Initiative

The Connecticut Clean Air Construction Initiative has built and improved upon the Massachusetts project that shares its name. The Connecticut Department of Transportation (ConnDOT) included contract specifications for work on the Q Bridge corridor project, a 7.2 mile stretch of I-95 in New Haven. ConnDOT had the advantage of being able to design the program prior to the start of any construction, which enabled them to add contract language into the initial bid packages and to implement an effective outreach program prior to the start of the contract requirements.

ConnDOT's contract specification requires all contractors and sub-contractors to reduce emissions from diesel-powered construction equipment with a 60 hp rating or above by installing emission control devices or by using cleaner fuels. The specification applies to equipment that is assigned to the contract for more than 30 days. The specification was written so that DOCs and the fuel additive PuriNOx™ would qualify, but the language was left general enough to allow for technological change. Retrofit equipment must be listed on EPA's or CARB's approved technology list and must reduce emissions 20 percent for PM, 40 percent for CO, and 50 percent for HC. Clean fuels are defined as diesel fuels that can be used without engine modification, reduce emissions by PM emissions by 30 percent and NOx by 10 percent as compared to No. 2 diesel fuel, and are included on CARB's verification list.

All affected contractors must provide an initial list of their existing off-road diesel-powered construction equipment, indicating which equipment will be retrofitted with emission control equipment or will use clean fuels. The report must include:

- The equipment number, type, make, and contractor/sub-contractor name
- The emission control device make, model, and EPA verification number
- The type and source of fuel to be used

Subsequent monthly reports must include the same information contained in the initial report, and they must include the following:

- Clean fuel delivery slips for the reporting time period, indicating which vehicles received the clean fuel
- The addition or deletion of off-road diesel equipment to a fleet
- The addition of any newly retrofitted equipment

ConnDOT tracks project equipment on a bimonthly basis for its duration on-site. If ConnDOT discovers a piece of diesel equipment is not in compliance with the contractor requirements, the contractor-owner receives a Notice of Non-Compliance and has 24 hours to bring the equipment into compliance or remove it from the project. If the 24-hour period expires without the equipment becoming compliant, all payments are withheld for work performed on any item(s) on which the non-compliant equipment was used for the time period in which the equipment was out of compliance.

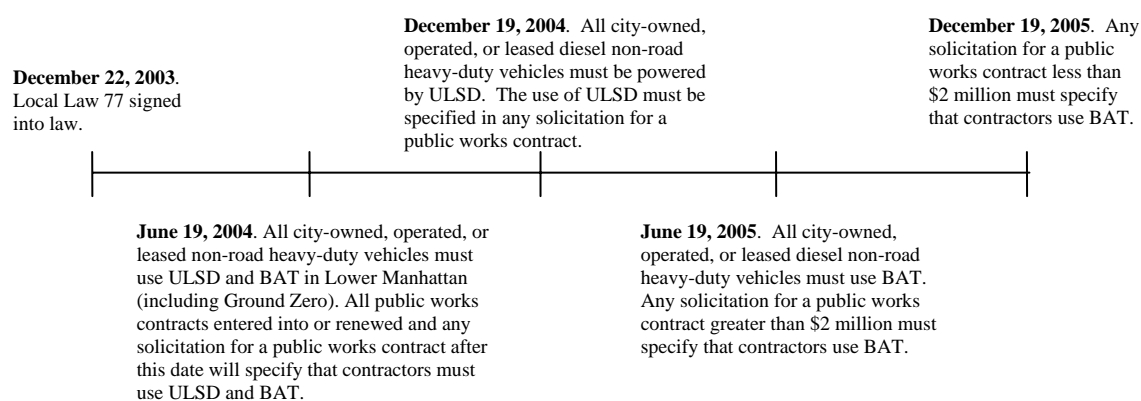
Retrofit and clean fuel costs are included in the contract as incidental costs; they are included in the overall bid price but are not itemized. The general nature of the covered costs allows the contractor to choose the best method to comply with the bid requirements. For example, a contractor who owns equipment may be more likely to retrofit its diesel engines to ensure continued emission reductions in future projects, while a contractor that rents equipment may prefer to use clean fuels.

Prior to awarding any contracts specifying diesel emission control, ConnDOT and program partners held a series of outreach meetings, the main goal of which was to communicate the program purpose and compliance requirements to the construction industry. Retrofit equipment vendors and clean fuel providers attended the meetings to address any contractor concerns, particularly regarding equipment maintenance and warranties.

As of June 2004, 64 pieces of equipment had been retrofitted, with 13 more on order. In addition, construction companies involved in the program have voluntarily switched to using on-road diesel (which has lower sulfur content) in their off-road equipment.

New York City Local Law No. 77

The nation's most extensive effort to use contract specification for diesel retrofits is occurring in New York City. Local Law No. 77 was signed into law on December 22, 2003. It requires the phased-in use of ULSD and "best available technology" (BAT) for emission control for use in all diesel-powered off-road vehicles used in city construction projects. The law applies to all diesel off-road vehicles with an engine rated at 50 hp or greater that is owned by, operated by or on behalf of, or leased by a city agency. Implementation of the law will be phased in, with the ultimate goal of city-wide use of ULSD and BAT by all city contractors, according to the following timeline:



The Commissioner of the New York City Department of Environmental Protection (NYC DEP) will regularly update the list of approved technology at least once every six months. Approved technologies will include those verified by EPA or CARB, and the Commissioner may also select non-verified technology at his/her discretion.⁴⁸ In selecting appropriate best available technologies, preference is given to technologies designed to reduce PM emissions; NOx emission reductions are considered of secondary importance. Any technology that increases the emissions of either pollutant is prohibited. Once an approved technology is installed, no city agency or contractor can be required to replace the BAT within three years of having first used the technology on an individual vehicle.

City agencies are provided loopholes to avoid the implementation of the contract specifications for a period of 60 days. If an agency finds that ULSD is not available in sufficient quantities to satisfy the contract requirement, the agency may request an exemption from the Commissioner. If granted, the exemption expires after 60 days and must be re-requested, but no ULSD exemption can be in effect after September 1, 2006 (when on-road ULSD will be available nationwide).

⁴⁸ Note that use of non-verified technologies might prevent the region from using the program for SIP credit.

Similarly, an agency may request an exemption from the BAT requirement under the following circumstances:

- When such technology does not exist for the vehicle to which the requirement is applied (the agency or contractor must then use whatever emission control technology is available and appropriate for that vehicle)
- When a diesel off-road heavy-duty vehicle is used for a specific public works contract for less than 20 days
- When, due to engine malfunction, the use of the technology might endanger the operator of the vehicle or those working near the vehicle

The contract requirements mandated by Local Law No. 77 are enforced with penalties for those contractors that violate the provisions of the law. If a contractor does not meet the contract requirements, he/she is subject to a civil fine between \$1,000 and \$10,000 plus twice the amount of money saved by the contractor for failing to comply with the requirements. In addition, any contractor making a false claim about his/her use of ULSD or BAT are subject to a civil fine of \$20,000 plus twice the amount of money saved by making the false claim.

At the moment, the timeline shown above, along with formal implementation of Local Law No. 77, has been delayed, as stakeholders try to define “best available technology”. Through a public stakeholder process consisting of meetings with NYC DEP, public hearings, and the opportunity to provide written comment, it is hoped that formal implementation will occur this summer (2005).

City of Austin’s Contract Provision Restricting Construction Activity on High-Ozone Days

As part of its Early Action Compact (EAC) agreements, the city of Austin, Texas, plans to incorporate language into its construction contracts that would restrict construction activity and equipment operation on high-ozone days. If adopted, the contract language would be in place until the end of Austin’s EAC commitment in 2012.

Austin designates “Ozone Action Days” when weather conditions have developed that encourage the build-up of atmospheric ozone at levels that are harmful to human health. On these days, the city encourages residents to limit activities that contribute to ozone formation. For example, the city encourages commuters to carpool or use public transportation when possible and to refuel their vehicles after dark.

The contract provision described above would apply when the National Ambient Air Quality Standard (NAAQS) for ozone is exceeded on an Ozone Action Day, and another Ozone Action Day is anticipated on the following day. As currently envisioned, the contract language would ban the operation of any construction equipment with a diesel engine rated at greater than 30 hp. Electric or clean gas engines would be exempt. Tarring of roofs and laying asphalt would also be restricted. In limiting construction activities on these days, the city hopes to reduce the potential for another violation of the NAAQS standard the following day.

Stakeholders from the contracting community publicly oppose any regulation limiting construction activity. They have noted that such regulations might delay completion of construction projects and drive up costs. However, the city stresses that historically there have been a maximum of eight days per year when this construction ban would have applied. In some past years, the construction ban would not have gone into effect at all. (If such regulations were adopted in a city with more severe ozone problems, the construction ban would be applied more frequently.) Currently, Austin’s Parks and Recreation

Department has voluntarily adopted the contract provision for its own operations, which include landscaping, mowing, and tending of municipal golf courses. In addition, the city hopes to soon implement the provision on a voluntary basis with its own bulldozers and construction equipment. The city has not identified an anticipated adoption date for the measure.

Other Examples of Contract Specifications

Contract specifications to promote emission reductions are reportedly being considered for or implemented in many new public works projects. One interviewee noted that these types of contract specifications are currently widely used in Southern California and appear to be spreading elsewhere. They are sometimes suggested by air quality agencies as a mitigation measure during the environmental review process.

Contract specifications have also been used for construction work at ports. For example, the contract for the Port of Oakland's 50-foot dredge project required the use of electric dredges instead of diesel-powered models. The Port of Seattle, which operates SeaTac Airport, recently issued construction specifications for an airport construction project that requires ULSD in vehicles used on the project (with the Port subsidizing the cost difference) and newer model year construction equipment. Use of contract specifications for port and airport improvements is often done to ensure that project emissions do not exceed the general conformity *de minimis* levels (see Section 7.3 for more information).

Discussion of Interview Findings

Contract specifications appear to be a highly effective means to achieve emission reductions in construction projects. They are strongly supported by environmental groups and have generated interest from a number of state and local governments. Contractors have expressed concern that the widespread adoption of contract specifications would devalue their existing equipment fleet. A contractor's equipment fleet makes up most of its assets and is used as collateral for loans and bonds. If a contractor were unable to use its fleet to compete for public contracts in its market, the value of its fleet would decline. Although larger firms would be affected, they are more likely than small companies to have cash reserves or access to capital to pay for retrofits, repowers, or replacement. Contract specifications might also adversely affect a company's financial statement, limiting its ability to borrow money and secure bonding for future projects.

Contractors, especially small firms, often rent off-road diesel equipment to supplement their own equipment fleet. Therefore, rental equipment companies need to be engaged and made aware of the needs of their clients for newer and cleaner equipment. Rental firms that retrofit their equipment will presumably be able to recoup their investment through higher rental fees.

Contract specifications will increase the cost of public works. In the absence of grants, tax incentives, or other types of reimbursement, construction firms will incur the full cost of retrofits themselves and will presumably build those additional costs into their bids. Thus, in a perfectly functioning free market, governments would pay the same cost for the emission reductions as they would if they offered a grant for the retrofits. In addition, the cost of public works might increase if the contract specification discourages enough bidders to limit competition for the contract. The actual cost of contract specifications to government is not known and probably difficult to assess. Because construction contracts are typically fixed price contracts, any contract specification should be done prior to the bidding process to ensure that companies are not forced to incur equipment costs that they are not able to recover.

Most of the examples of contract specifications discussed in this section stipulate that a certain percentage of the engines on a project incorporate a retrofit (often selected from a menu of choices) or meet a

specified emission standard (e.g., Tier 1). In contrast, some contract specifications in California reportedly estimate an average emission rate for the state or district, then require that the project equipment have emissions at a rate some percentage below this average. Contractors have expressed concern with this second type of specification structure, because the fleet average emission rates are often based on poor data, so the emission target in the contract is somewhat arbitrary and possibly difficult to achieve. Contractors have also expressed concern that specifications may be written by those without sufficient knowledge of construction equipment, resulting in specifications that are technically infeasible.

5.2 Port Lease Specifications

Similar to a contract specification, a port can stipulate environmental performance in its lease with a terminal operator. Each terminal operator signs a lease with the port authority. The period of the lease can vary widely even within a given port – some may be as short as five years, others may last 30 years. A terminal lease typically specifies the port's payment terms as well as operating requirements related to maximum vessel size and maximum cargo throughput. A lease can also specify environmental requirements. Because a lease is a legally-binding contract, this mechanism, like contract specifications, is not an "incentive" per se, but a requirement for companies that wish to maintain operations at a port.

Port of Los Angeles

One of the first instances of a port stipulating environmental performance as part of a terminal lease is the China Shipping terminal at the Port of Los Angeles. The expansion of this terminal and associated environmental review was the subject of litigation between the Port and a coalition of environmental groups. As part of the settlement agreement reached in March 2003, the Port will require cold ironing by container ships at the terminal and use of cleaner alternative fuel heavy-duty yard trucks at the terminal. In addition, the Port will require the purchase of only clean, alternative fuel yard tractors for all new leases and "significant" renegotiations of existing leases at other terminals.

The Port of Los Angeles is currently negotiating a five-year lease of the Berths 206-209 container terminal and will use the lease agreement to specify a number of environmental requirements that reduce diesel emissions. The Port's request for proposals for the terminal lease identifies the following terms and conditions:

1. Observation of the (voluntary) Vessel Speed Reduction Program, with a goal of 100 percent observation. This program encourages vessels to travel at or below 12 knots within 20 miles of the coast.
2. Utilization of the Alternative Maritime Power (AMP) Program (cold ironing), with 30 percent of ships utilizing AMP by the end of the second year, and 70 percent by the end of the third year. To meet this requirement, all AMP ships must call and unload/load cargo at the 206-209 Terminal. Unless a vessel is already AMP-capable, all AMP ships calling at the Terminal will need to be converted to be able to connect to AMP power receptacles provided at the wharf and utilize shore power for ship's power needs while at berth. For any ships that are not using AMP, low sulfur fuel is to be utilized in ship generators at berth, where feasible. Low sulfur fuel is defined as fuel with a maximum sulfur content of 2,000 ppm.
3. Use of alternative fuel in all new yard tractors.
4. All older tractors must utilize 100 percent emulsified fuel and DOCs.
5. Emulsified fuel and DOCs must be used on all other yard equipment, where feasible.
6. Maximization of on-dock or near-dock rail, with a goal of 65 percent of discretionary goods to be shipped via rail within two years.

7. The proposer must have a corporate environmental policy and/or Environmental Management System or equivalent.

Other Examples

Several interviewees suggested that the Port of Long Beach is likely to include similar environmental requirements when it next negotiates a major terminal lease. Some ports may require actions to reduce dust emissions as part of a lease, such as vehicle speed reduction, chemical suppression in unpaved areas, or requirements to control petroleum coke dust by enclosing conveyer belts and open coke piles.

However, it does not appear that port terminal leases have been used to stipulate mobile source emission reduction measures anywhere other than the Port of Los Angeles. Most of the ports we interviewed were familiar with the Port of Los Angeles example but did not believe that similar terminal lease specifications would spread beyond Southern California in the near future.

A related concept is the use of the port-wide tariff to promote emission reductions. A “tariff” is the schedule of rates, rules, and regulations published by each port authority. It typically applies to most or all port tenants. The port tariff specifies procedures and fees for services like vessel piloting, dockage, and use of wharf space, as well as water and electricity rates. It also contains various operating requirements such as restrictions on discharge of ballast water, limits on vessel speed in the harbor, and requirements designed to prevent chemical spills. There was consideration at the Port of Long Beach to use the port tariff to require practices that would reduce diesel emissions, such as the use of cleaner fuels or after-treatment devices on cargo handling equipment. However, CARB informed the Port that such blanket requirements are not within the Port’s authority, so active consideration of this approach has been dropped.

Discussion of Interview Findings

Opinions vary widely about the effectiveness of port lease specifications as a tool to promote diesel emission reductions. Some environmental group and government agency stakeholders feel this option can be an effective mechanism to reduce port emissions. Clearly the environmental requirements being specified at the Port of Los Angeles will raise operating costs for the terminal operators. A port cannot succeed in stipulating such requirements unless there is sufficient demand for space at the port. Potential tenants will consider other ports if the lease terms are considered too onerous. Overly burdensome lease specifications might cause shippers to divert traffic to other ports or to other terminals within the same port that do not have such requirements. Outside of Southern California, all the ports we interviewed did not feel that they could currently include diesel emission reduction measures in a terminal lease because it would harm their competitive position.

In places where demand for port space is sufficient to allow lease specifications, there are questions about how effectively this mechanism would achieve port-wide emission reductions. Operating requirements can only be modified in a lease when the “master agreement” is renegotiated. This happens then the lease expires or when there is a major expansion at the terminal that necessitates a new lease. While many leases are written to require “re-opening” every five years, this re-opening typically allows only negotiation over rent, guaranteed minimum returns, and insurance. Because some terminal leases can last decades, the use of lease specifications to achieve port-wide emission reductions would likely take a long time. Of course, if a port faced overwhelming pressure to change a lease, it could always opt to break the lease and pay damages to the terminal operator.

Use of lease specifications also raises issues of fairness. Terminal operators that happen to have their lease expiring would be subject to operating requirements that would not apply to neighboring terminals.

A port could not use this mechanism to selectively target the terminals that contribute most significantly to regional emissions.

Some stakeholders have expressed concern that terminal lease specifications might stipulate emission reduction measures that sound appealing or are popular with environmental or community advocacy groups, but in reality are not cost-effective or technologically feasible. Terminal operators may prefer that the port set an emission reduction target and allow the operators to select the best approach to achieve the target. Or they may simply prefer that emission reduction measures be left in the hands of state air quality agencies.

5.3 Contract Preferences

A state or local agency that is contracting for construction work could establish evaluation criteria that favor bidders that commit to using emission reduction strategies in performing the work, but do not explicitly require these strategies. Agencies could structure this preference any number of ways. If the preference is large enough, it would in effect require a bidder to use cleaner equipment in order to win. If the preference is too small, it might not affect the award outcome at all. There are no widely recognized examples of contract preferences being used to encourage the use of cleaner off-road diesel equipment, although several cities have reportedly considered adoption of such preferences, including Seattle.

A contract preference has the advantage of not completely disqualifying construction firms that have not yet been able to retrofit, repower, or replace their older off-road diesel equipment. Such firms could in theory still win contracts but would have to beat other bidders on the basis of price or other evaluation criteria. A disadvantage of a contract preference is that it makes it difficult for a construction firm to decide whether to invest in retrofits, repowers, or replacements. The advantages to the company are less clear. A disadvantage from the perspective of those concerned with air quality is that emission reductions are not guaranteed with a contract preference. It may be difficult to predict whether the winning bidder of a contract will take advantage of the preference for those committing to use equipment with lower emissions. Public agencies and contractors alike may prefer another policy option that offers more certainty for everyone involved.

5.4 Contract Allowances

With a contract allowance, a state or local agency would award a construction contract to the lowest bidder and would provide additional funding to the winning bidder to take steps to reduce emissions from diesel equipment used on the project. A contract allowance is in effect a grant that is tied to a particular construction contract. Another possible implementation of a contract allowance is an optional incentive payment for the use of cleaner diesel equipment and fuel. Instead of requiring diesel retrofits and paying for them, a contracting agency would include monetary incentives in the contract for the use of cleaner equipment and fuel. These incentives would be similar to others often included in contracts for early completion.

Although contract allowances are reportedly under consideration in several places including New York City, the City of Atlanta and the Texas Department of Transportation appear to be the only government agencies that have actually tried this mechanism.

Runway Construction at Atlanta's Hartsfield-Jackson International Airport

The City of Atlanta owns and operates Atlanta's Hartsfield-Jackson International airport. To reduce delays and prepare for future demand, the airport is constructing a fifth runway. The new runway, which is scheduled to be commissioned in May 2006, will be one of the most complex structures of its kind in

the world. When completed, the runway will span Interstate 285, which can accommodate up to 18 lanes of traffic.

In one of its construction contracts for the new runway, the airport set aside a diesel retrofit allowance for the winning bidder. However, at the time, there were no EPA- or CARB-certified technologies for the equipment in question, and the winning contractor was concerned about voiding the equipment warranties by installing non-certified retrofit equipment. Instead of using the allowance for diesel retrofits, the airport agreed to use the contract allowance to help the contractor purchase a dump truck powered by liquefied natural gas.

Texas DOT Contract Incentives for Diesel Emission Reduction

The Texas Department of Transportation (TxDOT) has drawn up contract provisions that provide financial incentives for contractors to use low-sulfur diesel and Tier 1, 2, or 3 off-road diesel engines on construction projects in non-attainment and near non-attainment areas of the state. These provisions were informed by the participation of TxDOT in the Texas Clean Air Working Group sponsored by the Texas Conference of Urban Counties. The working group developed model contract specifications that counties, cities, and the state could adapt and incorporate into their construction contracts.

The incentive provision applies to non-road engines of 50 hp or greater. Each engine must be certified by EPA or CARB or otherwise accepted by TCEQ as meeting EPA's Tier 1, 2, or 3 non-road emission standards. The incentive payments are based on each engine's horsepower rating. The monthly payment rate for a Tier 1 engine is \$0.50 per engine horsepower rating. The payment rates for Tier 2 and 3 engines are \$0.75 and \$1.00, respectively. The incentive payments will be prorated for equipment that is not in use for an entire month. The contractor must notify TxDOT in writing to request incentive payments.

The TxDOT incentives will also provide compensation for the cost difference between low-sulfur diesel and standard off-road diesel. The incentive payment covers the cost differential plus an additional \$0.10 per gallon for all additional costs for furnishing, storing, and dispensing the low-sulfur diesel. This incentive has been available since June 2004 and will remain in effect until October 2005, the likely effective date of the state's requirement for use of low-sulfur diesel.⁴⁹ Again, the contractor must notify the agency in writing to request incentive payments.

According to TxDOT, these incentive provisions are meant to supplement, not supplant, the state's TERP program. The incentive payments are not large enough to cover the full cost of engine retrofits, repowers, or replacements. However, they may be large enough to encourage companies to use their newest equipment for projects in the state's non-attainment areas. Also, the incentives will provide at least partial compensation to companies that do not qualify for the TERP program's grant funding. The fuel and emissions incentives have been available since June and September 2004, respectively; no company has yet applied for payment.

Discussion of Interview Findings

A contract allowance can be structured like a contract specification paired with a grant to the winning bidder (e.g., the emission reductions are required), or can merely provide optional incentives to encourage the contractor to invest in emission reduction technologies. With either a specification or an allowance, the contracting agency will pay more for the construction project in question. With a contract allowance,

⁴⁹ TCEQ is currently going through the rule-making process to change the effective date of its requirement for low-emission diesel from April 2005 to October 2005.

the additional price of requiring cleaner diesel equipment is explicit, whereas, with a contract specification, the additional cost of using cleaner fuel or equipment is built into the bids.

One advantage of a contract allowance is that it does not penalize firms that haven't been able to finance cleaner diesel equipment on their own or to obtain other assistance to do so. Allowances would help smaller construction companies remain competitive for public contracts. In addition, as more firms improve their equipment, contract allowances would, in theory, go unused.

One question that arises with contract allowances is whether a company would be eligible for more than one allowance from any one agency. In theory, even after retrofitting some equipment with an allowance, a contractor could bid its oldest equipment on the next job in an effort to get public funding for retrofits of that equipment.

Another question concerns equipment that has a useful life well beyond the term of a particular contract. With a contract allowance, an agency would pay the full price of improving the equipment even though the equipment would be used on other jobs (public and private) in the future. In contrast, if firms paid for equipment improvements on their own, they would presumably attempt to recover the costs over the remaining useful life of the equipment, spreading the costs of the diesel emission reduction technology among multiple agencies.

To implement a contract allowance, a contractor would need sufficient time between the contract award and the groundbreaking for the project to perform the retrofits or other improvements. This type of incentive would probably not work to promote repowering, which can take six months or more for large construction equipment.

Based on our interviews, it appears that contract allowances would be best used as a way to help ensure fair treatment of small businesses when an agency is implementing a contract specification. As discussed in Section 5.1, there are concerns that contract specifications might disenfranchise small contractors who cannot as easily finance emission reduction technologies. In the case of New York City Local Law No. 77, for example, contractors have raised concerns that a small number of large companies might invest in cleaner equipment and then monopolize New York City public works projects. By using contract allowances in concert with the contract specifications, small businesses would be allowed to perform the improvements necessary to compete in New York.

5.5 Summary of Findings on Modified Contracting Procedures

The federal Clean Air Act generally prohibits state and local governments from establishing emission standards for diesel engines. However, states and localities control billions of dollars of construction contracts, and they can require or encourage bidders on construction contracts to use newer equipment, to retrofit or repower equipment, and to use cleaner fuel. Likewise, ports oversee marine terminal operations that are of great economic value. Ports seeking to reduce diesel emissions from off-road equipment can require terminal operators to take actions to lower emissions through lease specifications, or can encourage emission reductions through voluntary programs (as described in other sections of this report).

More and more state and local agencies are beginning to use contract provisions to achieve reductions in off-road diesel emissions. Contract specifications, which in effect regulate emissions, appear to be growing in popularity following several high profile examples: Massachusetts' Big Dig and Connecticut's Q Bridge I-95 project. The nation's most extensive effort to use contract specification for diesel retrofits is occurring in New York City, where Local Law No. 77 will soon require use of ULSD and "best available technology" for emission control in all diesel-powered off-road equipment used in city construction projects. Environmental groups strongly support this approach to diesel emission reduction.

The first experiences with contract specifications suggest several steps that states and localities can take to ensure success. First, agencies should engage the contracting community to ensure that companies are aware of the future requirements and have time to prepare for them. Second, the provisions should be written as performance requirements so that they do not discourage the development and use of new technologies. Third, contract provisions should contain options for waivers or exemptions for equipment for which there is no effective retrofit technology or fuel choice.

The proliferation of contract specifications is a major concern to the contracting community for several reasons. One reason is the potential effects on small businesses. Small contracting companies may not have the ability to finance the equipment upgrades necessary to win work under a contract specification. If implemented widely in a particular region, contract specifications could shrink the market for a construction company with a fleet of older diesel equipment, which would devalue the company's assets. Construction companies have also voiced concern that contract specifications might adversely affect a company's financial statement, limiting its ability to borrow money and secure bonding for future projects.

A contract allowance incorporates a payment to the contractor to offset, fully or partially, the cost of emission reduction investments. A contract allowance can be structured like a contract specification paired with a grant to the winning bidder (e.g., the emission reductions are required), or can merely provide optional incentives to encourage the contractor to invest in emission reduction technologies. Contract allowances may provide a mechanism to help level the playing field for small contractors who cannot on their own finance investments in emission reduction technologies. Concurrent implementation of a grant program or tax incentive would help these companies bring their fleet into compliance and remain eligible for public works contracts.

Lease specifications can allow a port to stipulate a variety of emission reduction measures at marine terminals, for both vessels and cargo handling equipment. The Port of Los Angeles is currently requiring a number of emission reduction measures as part of a new terminal lease, including vessel electrification (cold ironing), retrofits on yard tractors, and use of emulsified fuel in cargo handling equipment. However, this mechanism appears unlikely to spread widely outside Southern California in the near term, because most ports are hesitant to stipulate diesel emission reductions in a lease for fear it would harm their competitive position. The effectiveness of lease specifications in achieving port-wide emission reductions is hindered by the long leases at many terminals and, thus, infrequent opportunities to negotiate new lease terms.

6 ENVIRONMENTAL STEWARDSHIP AND NON-MONETARY INCENTIVES

Grants, tax incentives, and contracting incentives help to encourage owners of off-road diesel equipment to take actions to reduce emissions. There are also ways that government agencies can encourage emission reductions without offering monetary incentives. For a number of reasons, port authorities, terminal operators, and construction companies might take steps to reduce emissions in name of improving operating efficiency or embracing environmental stewardship. Companies are increasingly finding that it makes good business sense to proactively embrace environmental stewardship rather than react to government regulation or a negative public image. Government can help encourage these steps by offering guidance, education, and recognition.

6.1 Operating Efficiencies

Improving the operational efficiency of port and construction activities often results in lower fuel use and emissions. For example, improvements to port gate operation can improve truck access to marine terminals, resulting in reduced vehicle queuing and idling. Greater use of on-dock rail can reduce truck trips to and from a port, typically cutting emissions as a result. Minimizing the time vessels spend in port helps to limit emissions from auxiliary engines. Construction activities consume less fuel and produce fewer emissions when unnecessary equipment idling is minimized.

Of course, companies are always striving to improve efficiency in order to reduce their operating costs and improve profitability. Most of the operational improvements that reduce emissions will be undertaken in the normal course of business process improvement. But there can also be a role for government in identifying and promoting additional strategies for operational improvement. For example, EPA's SmartWay Transport program has focused on identifying strategies to reduce fuel use (and emissions) in on-road trucking, with some success. The Lane Regional Air Pollution Authority (Oregon) has established a program to promote installation of auxiliary power units (APUs) on long-haul trucks, helping truck owners to secure financing and apply for Oregon's tax credit (described in Section 4.1).⁵⁰

Key Findings on Environmental Stewardship

1. *There are a number of ways to improve the operational efficiency of port and construction activities, which often results in lower fuel use. These "win-win" solutions lower operating costs for the company and reduce emissions for the region. Examples include reducing equipment idling, port gate improvements, and greater use of on-dock rail.*
2. *An environmental management system (EMS) provides a framework to integrate environmental decision-making into an organization's day-to-day operations, making it easier to find and fix the root causes of potential environmental problems. Organizations with an EMS benefit in numerous ways, including improved community relations and public image, cost savings, and better internal communication. Adoption of an EMS can also allow an organization to receive ISO 14001 certification. The Port of Houston Authority became the first U.S. port to receive ISO 14001 certification and anticipates substantial benefits in its insurance coverage as a result. The Port of Boston's Conley Container Terminal also recently received ISO 14001 certification.*
3. *Government agencies can encourage environmental stewardship by:*
 - *Providing public recognition*
 - *Providing educational information about opportunities to reduce emissions or improve efficiency*
 - *Providing guidance on voluntary actions to assess current emissions and how to plan for improvements*
 - *Acting as a facilitator to create opportunities for information exchange and to leverage additional funding*

⁵⁰ See program website at www.apucentral.com

Government agencies can also help to educate companies about opportunities to improve efficiency by facilitating peer exchanges.

The current focus on improving port security may generate some opportunities for more efficient logistics at ports. More extensive use of electronic identification of containers, for example, may help to identify ways to minimize the transport of empty containers. While operational improvements would likely result in a relatively small reduction in emissions for any single piece of equipment, these strategies have the potential to be applied much more widely than technological strategies like retrofits, so their cumulative effect could be significant.

6.2 Environmental Management Systems

Many of the opportunities for diesel emission reduction can be identified through an effective Environmental Management System (EMS). An EMS provides a framework to integrate environmental decision-making into an organization's day-to-day operations. An EMS makes it easier to find and fix the root causes of potential environmental problems and to improve environmental performance, prevent pollution, and conserve energy and natural resources. The possible benefits of an EMS include:

- Improved community relations and public image
- Cost savings
- Improved environmental compliance
- Improved internal communication
- Integration of environmental and security risk management
- Increased competitiveness and market opportunities

While each EMS is unique, most follow the "Plan-Do-Check-Act" model. This approach establishes a framework to examine the environmental aspects of an organization, then develop, implement, monitor, review, and revise environmental programs and procedures to continually promote improvement. An EMS does not need to be a stand-alone system, but rather can bolster other quality management programs, such as health and safety, security and risk management, records management, and community and regulator relations. Many ports and construction companies already have components of an EMS in place that they can build upon, such as written and unwritten procedures, best management practices, and regulatory compliance programs.

Adoption of an EMS can also allow an organization to receive ISO 14001 certification. The International Organization for Standardization (ISO) released ISO 14001 in 1996 as the international standard for developing and implementing an effective EMS. By achieving ISO 14001 certification, an organization gains international recognition as an environmental leader. In addition, ISO 14001 ultimately may be required for companies to attain ISO 9001, which pertains to Quality Management Systems and is vital to ensuring competitiveness in some markets.

EMS Benefits

The systematic approach of an EMS can help identify, analyze, and respond to environmental responsibilities. Rather than retroactively responding to an unforeseen environmental problem, an EMS allows for forward planning to help prevent potential problems from being overlooked and helps identify the root causes of such problems in order to avoid them in the first place. This predictable environmental performance can help avoid violations, fines, and work stoppages that can damage public image.

Confronting and planning for problems is frequently more cost-effective than managing the negative repercussions after problems surface. These savings can allow port owners and operators and construction contractors to make other investments – such as equipment upgrades or specialized workforce training – to increase their profitability and competitiveness.

An EMS can also reduce costs by helping to identify opportunities for efficiency improvements. Companies with an EMS have achieved significant cost savings as a result of

- More efficient use of time and materials
- Reduced waste and associated disposal costs
- Reduced water and energy use
- Reduced pollution incidents and clean-up costs

In addition to enhancing public image by facilitating open communication with their communities, ports and construction contractors that adopt an EMS can build a positive relationship with regulators by taking advantage of state and national incentive programs. EPA's National Environmental Performance Track offers incentives ranging from public recognition to regulatory flexibility and low-priority inspection status to facilities that consistently perform beyond regulatory compliance. An EMS can help set organizational goals and priorities, such as reducing air emissions, and help implement programs to meet stated goals. An EMS requires ongoing monitoring to track progress and ensure that targets are reached within their intended timeframe.

EMS Examples

In 1999, as part of EPA's EMS Initiative for Local Government Entities, the Port of Houston Authority (PHA) received training and technical assistance in implementing an EMS at its Barbours Cut Container Terminal and its Central Maintenance Facility. The EMS established three priority areas: stormwater impacts, waste minimization, and air emission reductions (reduce NO_x by 25 percent and PM by 30 percent). Four years after adoption of an EMS (1999 through 2002), PHA had reduced emissions of NO_x by 7.8 tons per year (tpy) and PM emissions by 0.83 tpy. As a result of EMS documentation and operational controls, PHA is the first U.S. port to receive ISO 14001 certification and anticipates substantial benefits in its insurance coverage as a result. The Port of Boston's Conley Container Terminal also recently received ISO 14001 certification.

Experiential data from public agencies that have adopted EMSs suggest that the primary costs associated with establishing an EMS are direct labor costs. The Public Entity Environmental Management System Resource (PEER) Center reports that direct labor costs have averaged about eight hours per employee per year to integrate EMS activities into their daily routine. PHA implemented its EMS over 1,895 direct internal labor hours at a total projected internal labor cost of approximately \$100,000. Since successfully implementing its EMS, PHA has established itself as an environmental leader, contributing to environmental discussions throughout Texas and providing assistance to other ports worldwide.

AAPA and AGC are partner trade associations working with EPA as part of the Sector Strategies program. One of the tenets of these partnerships is the promotion of EMS throughout AAPA and AGC membership. Working with AAPA and AGC, EPA has developed brochures highlighting the benefits of EMS implementation specifically for ports and construction companies.⁵¹

⁵¹ See <http://www.epa.gov/sectors/emsbizcase.html>

EPA, AAPA, and the Global Environment and Technology Foundation have collaborated to provide ports with EMS training, mentoring, and technical assistance. In December 2003, the following 11 ports were selected to participate in this two-year program:

Port of Houston Authority	Port of Portland, OR
Port of Los Angeles	MARAD – Fort Eustis, VA
Virginia Port Authority	Portland District Corps of Engineers (Portland, OR)
Port of New Orleans	Port of Vancouver, WA
Port of Corpus Christi Authority	The Port Authority of New York & New Jersey
Port Everglades (Fort Lauderdale, FL)	

6.3 Role of Public Agencies in Promoting Environmental Stewardship

Government agencies can encourage environmental stewardship in many ways. One is providing recognition for superior environmental performance. EPA's SmartWay Transport program is an example of a program that encourages improvements in truck fuel efficiency by providing public recognition to those who commit to improvement (see Section 2.4). SmartWay Transport partners who meet the program's goals are allowed to use the SmartWay logo on their stationary and advertising, similar to the ENERGY STAR program for appliances and buildings. For ports, terminal operators, or contractors that value a "green" public image, such recognition can be an incentive to take steps to reduce diesel emissions.

Similarly, ports can develop award programs that recognize environmental stewardship by tenants or shipping lines. The Ports of Los Angeles and Long Beach have already initiated the development of branding programs that will offer awards to tenants and will give flags to vessels that obey the voluntary speed limits. Ports are also interested in developing a common logo that would brand and create widespread recognition for environmental stewardship efforts.

Public agencies can offer guidance to companies that are interested in environmental stewardship. As described in Section 6.2, EPA is currently collaborating to offer EMS training, mentoring, and technical assistance to 11 selected ports. EPA is also planning to provide tools to help ports in the development of an emission inventory. Establishing an emission inventory is a prerequisite to an effective emission reduction program, because it identifies in detail the current sources of emissions at a port or a jurisdiction. Once emission sources have been identified, public agencies can assist companies with setting non-binding goals for emission reductions. This provides a mechanism to track progress and focus internal and external attention on emission reduction efforts, thereby helping to ensure that commitments are carried out.

Finally, government agencies can serve an important role as facilitators and educators. By highlighting success stories and creating opportunities for information exchange between peers, agencies can create momentum for further emission reduction projects. This process can also help to leverage additional funding for emission reduction projects. EPA's West Coast Collaborative serves this function (see Section 2.4). For example, the Collaborative coordinated a series of eight press events held on September 30, 2004, to announce \$9 million of diesel mitigation projects along the West Coast, calling attention to the public health and environmental impacts associated with diesel emissions and highlighting the need for additional resources. All eight events garnered both regional and national media recognition in support of the partnership.

7 OTHER TYPES OF INCENTIVES

This section reviews other types of incentives to reduce off-road diesel emission that do not fall into the four major categories covered in Sections 3 – 6. These include the following:

- SIP credits
- Emissions trading programs, such as mobile source emission reduction credits
- General conformity credits
- Supplemental Environmental Projects
- The Coast Guard's Qualship 21 program
- Differentiated port fees
- Building permit fee rebates

Many of these other types of incentives are limited to a small number of companies or face significant barriers to implementation.

7.1 State Implementation Plan Credits

The Clean Air Act Amendments (CAAA) of 1990 require states with areas that do not meet National Ambient Air Quality Standards (NAAQS) to submit to EPA a State Implementation Plan (SIP) that documents how the area(s) will achieve NAAQS within the required time frame. When the projected emissions in a region exceed the level necessary to achieve NAAQS, the state must adopt control measures to reduce emissions. Programs that reduce diesel emissions from construction or port sectors can provide states with credit toward required SIP emission reductions. Thus, this incentive applies primarily to state air quality agencies, which must comply with the CAAA, rather than private companies. SIP credit was one of the primary motivating factors that led to the development of the Moyer and TERP Programs. By definition, SIP credits apply only to areas that are classified as non-attainment or maintenance areas.

Key Findings on Other Types of Incentives

1. *SIP credits are an incentive inherent to the Clean Air Act and apply to all state air quality agencies with areas in violation of national air quality standards. Voluntary Mobile Source Emission Reduction Programs (VMEPs) rely on the voluntary actions of individuals or businesses to achieve emission reductions and offer more flexibility than traditional SIP control measures.*
2. *Mobile source emission reduction credits (MERCs) are generated when a company reduces transportation emissions beyond what is required and sells the credits to other companies covered by a tradable permit system. Although some states and regions have taken steps to encourage generation of MERCs by off-road diesel sources, MERCs have proven impractical to date because of the costs associated with quantifying and certifying the emission reductions.*
3. *General conformity credits could provide an incentive for ports to take early action to reduce diesel emissions by ensuring that the port can later use the emission reductions to satisfy general conformity requirements during construction.*
4. *Supplemental Environmental Projects (SEPs) are environmentally beneficial projects that a violator of a federal environmental law is not otherwise legally required to perform, but voluntarily agrees to undertake in settlement of enforcement action. As an incentive, SEPs apply only to companies that have violated federal environmental laws.*
5. *The U.S. Coast Guard's Qualship 21 program offers to reduce the frequency of vessel safety inspections for ships that demonstrate a quality track record. This type of program could possibly be expanded to offer incentives to vessels that comply with international emissions standards.*
6. *Differentiated port fees could be used to promote low sulfur bunker fuels or other emission reductions technologies on ships. This type of incentive is currently offered in Europe. It is one of the few opportunities to influence emissions from oceangoing marine vessels, most of which are not U.S.-owned.*
7. *Local governments could offer building permit fee rebates to construction companies as an incentive to implement emission reduction measures for building construction projects.*

Control measures have been classified by EPA based on source category and operational mechanism. Several types of measures potentially apply to off-road diesel equipment. Transportation Control Measures (TCMs) refer to measures designed to reduce emissions from transportation sources through a reduction in vehicle use or changes in traffic conditions. TCMs typically apply to on-road vehicles, although “idling restrictions” is listed in Section 108(f) of the CAAA as one example of a TCM. Economic Incentive Programs are control measures that rely on market-based incentives to reduce emissions and increase compliance flexibility. Voluntary Mobile Source Emission Reduction Programs (VMEPs) refer to measures that rely on the voluntary actions of individuals or businesses to reduce emissions.

Under the CAAA, all SIP measures must be consistent with SIP attainment and Rate of Progress requirements. They must result in emission reductions that are quantifiable, enforceable, and permanent. Quantifiable means that the emission reduction can be measured reliably and can be replicated. Enforceable means that the actions required to achieve emission reductions are independently verifiable, program violations are defined, those liable can be identified, and penalties can be applied where applicable. Permanent means that the emission reduction occurs throughout the life of the measure and for as long as it is relied upon in the SIP. While these principles apply to all SIP measures, EPA has provided guidance that clarifies how the principles can be interpreted for some of the specific classes of measures.

VMEPs rely on the voluntary actions of individuals or businesses to achieve emission reductions. EPA released guidance on incorporating VMEPs into SIPs in 1997.⁵² The guidance offers more flexibility for the adoption of voluntary measures, recognizing that the standard SIP requirements can be overly burdensome for voluntary measures that typically offer only small emission reductions. Like other SIP measures, voluntary measures must be consistent with SIP attainment and Rate of Progress requirements, and the emission reductions must be quantifiable, enforceable, permanent, and surplus. Voluntary measures differ from other SIP measures in that EPA does not require direct state authority over the program. A VMEP program can be implemented by a local or regional government or by a private entity. The state is, however, required to monitor, assess, and report on the implementation of the VMEP and must make up any shortfall in emission reductions. Since states have only limited experience in measuring the effectiveness of voluntary programs, EPA has limited the emission reduction allowed under VMEP to three percent of the inventory for each criteria pollutant.

An example of the use of VMEPs for off-road diesel emission reductions is the voluntary agreement by the Texas Waterway Operators Association (TWOA) to reduce marine vessel emissions in the Houston area. TWOA represents 23 tug, barge, and vessel towing companies. TWOA signed a Memorandum of Agreement in June 2001 to reduce their emissions by 1.1 tons per day of NO_x, taking actions such as early integration of new marine engines or the retrofit of existing engines, local fleet management by using more efficient equipment, and application of methods to reduce tug and towing vessel idling time. The emission reductions resulting from this Agreement are included in the Houston region ozone SIP.

VMEPs appear to provide states with an opportunity to gain badly needed SIP credits for off-road diesel emission reduction programs. They appear to be underutilized by many states, in part because they are a relatively new type of measure and may be unfamiliar to some air quality planners. States might also shy away from VMEPs if they perceive any uncertainty in the emission reduction, because the state must make up any shortfall. States that have established diesel emission reduction grant programs (such as California and Texas) are more likely to take advantage of these credits because they are confident they will be able to partner with industry to secure voluntary commitments. The Moyer and TERP programs both provide guidance on calculating emission reductions that could be used to quantify VMEP credit.

⁵² Guidance on Incorporating Voluntary Mobile Source Emission Reduction Programs in State Implementation Plans (SIPs), Memorandum from Richard D. Wilson, U.S. Environmental Protection Agency, October 24, 1997.

7.2 Emissions Trading Programs

Under an emissions credit trading program, sources can earn credit for reducing emissions beyond what is required by pre-existing regulations. These credits can then be traded (sold) to other facilities where they can be used to satisfy mandatory limits on emissions, or traded in a stand-alone cap and trade program (discussed below). Credit trading is also sometimes referred to as “project-based trading” or “offset trading.”⁵³ An example of this type of program is the offset requirements for new sources (e.g., power plants) in areas that do not meet NAAQS.

Mobile Source Emission Reduction Credits

Under most emissions credit trading programs, credits are traded between similar sources (e.g., credits generated by one power plant are traded to another power plant). Mobile source emission reduction credits (MERCs) are generated when emissions are reduced from on-road or off-road transportation sources. Many states and regions have adopted programs that allow MERCs to be used for stationary source NOx emission offsets.⁵⁴

In theory, MERCs can provide an incentive for construction companies or port terminal operators to voluntarily reduce emissions from off-road diesel equipment. Some states and regions have taken steps to specifically encourage generation of MERCs by off-road diesel sources. For example, in 2001 the South Coast Air Quality Management District adopted rules for six pilot MERC programs to generate NOx reduction credits that can be sold into the Regional Clean Air Incentives Market (RECLAIM). These programs entail:

- Replacement of diesel-fueled heavy-duty vehicles or yard hostlers with clean technologies
- Repowering or engine remanufacturing of diesel-fueled marine vessels
- Use of electric power during marine vessel hotelling operations
- Electrification of truck/trailer refrigeration units
- Truck stop electrification
- Electrification of agricultural pumps

Under these types of programs, the owner of off-road diesel equipment could voluntarily reduce emissions from the equipment, then generate and sell MERCs. In practice, however, there have been very few examples of the generation of MERCs. To date, the only major use of MERCs to offset stationary source emissions is the Otay Mesa power plant in San Diego County. Calpine Corporation (formally owned by PG&E Generating) is required under the Clean Air Act to offset NOx emissions increases resulting from the proposed 510 megawatt power plant. A portion of the total offsets required by Otay Mesa will be reductions from MERCs, while the remaining emission reductions will be provided by reductions at stationary sources. To generate the MERCs, Calpine Corporation will:

1. Replace existing heavy-duty diesel vehicles with new natural gas (or propane/diesel dual) fueled vehicles; and/or
2. Re-power existing diesel-powered engines with natural gas engines (cleaner burning diesel is also being considered for the marine vessels).

⁵³ See <http://www.epa.gov/airmarkets/capandtrade/tradingtypes.pdf>

⁵⁴ These states include Arizona, California, Colorado, Delaware, Idaho, Louisiana, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Pennsylvania, Texas, and West Virginia. Source: Diesel Technology Forum, *Cleaner Air, Better Performance: Strategies for Upgrading and Modernizing Diesel Engines*, May 2003.

The limited use of MERCs to date can be attributed to several factors. The region must have a NO_x credit trading program in place and must have a market for NO_x credits. The entity generating the MERCs must be able to achieve the reductions at a cost that is competitive with the going rate in the region. A regulating authority must establish protocols for baselines, monitoring, and verification to ensure that emission offsets are consistent, quantifiable, surplus, and long-term.⁵⁵ Considerable time and expense is often required to quantify and verify the emission reductions in a manner that meets the state rules. For example, a scrappage program for older vehicles must include careful monitoring to ensure the vehicles are permanently destroyed, which adds to program implementation costs. Moreover, in many regions the price for NO_x credits has been volatile, making it difficult to plan for the creation of MERCs in advance.

In one sense, however, the generation of MERCs might be easier for ports, terminal operators, and construction companies than for the stationary sources that typically generate emission reduction credits. Power companies, such as in the Otay Mesa example above, do not have a strong understanding of diesel equipment operations and must rely on consultants to quantify and verify the reduction. This process contributes to high certification costs, a major barrier to greater use of MERCs. The certification process could be streamlined (and costs reduced) if the entities pursuing the credits are the same as those generating the emissions that will be reduced – e.g., port operators and construction companies.

Other Types of Emissions Trading Programs

Emissions credit trading is one of three major types of trading programs. The other two – cap and trade programs and rate-based trading programs – are less applicable to mobile sources. In a cap and trade program, an aggregate emission cap is established that specifies the maximum amount of emissions authorized from the sources included in the program.⁵⁶ Sources are allocated a fixed number of “allowances” that represent authorization to emit a specific quantity of a pollutant (e.g., one ton). At the end of the compliance period, sources must hold enough allowances to cover their emissions during the period. Sources that do not have sufficient allowances must purchase them from sources that have excess allowances.

When structured properly, cap and trade programs provide a mechanism to limit emissions with a high degree of certainty while minimizing compliance costs. Existing examples include the U.S. SO₂ Allowance Trading Program (also known as the Acid Rain Program), the Ozone Transport Commission Regional NO_x Trading Program in the Northeastern U.S., and the RECLAIM program in Southern California. A stand-alone cap and trade program is unlikely to be appropriate for mobile sources. However, as mentioned above, there have been efforts to allow MERCs to be sold into existing cap and trade programs.

The development of cap and trade programs has been based in part on earlier experiences with bubble policies. First established in 1979, a bubble policy applies a single aggregate emission limit to multiple sources within a facility. Rather than regulate emission control equipment or emission rates on each individual source, an entire facility (such as a power plant or refinery) or group of facilities is subject to only one aggregate emission limit. The facility is free to employ a mix of controls that is most cost-effective as long as total emissions under the “bubble” are not exceeded. In theory, a bubble policy could be applied to a port. Bubble policies have been used infrequently because the process for reviewing and approving such policies has proven burdensome.

⁵⁵ California Air Resources Board, *Mobile Source Emission Reduction Credits: Guidelines for the Generation and Use of Mobile Source Emission Reduction Credits*, February 1996.

⁵⁶ For more information on cap and trade programs, see <http://www.epa.gov/airmarkt/trading/index.html>

The other major type of emissions trading program is a rate-based trading program. A regulatory authority establishes an emission rate performance standard (e.g., tons of emissions per megawatt hour of electricity generated). The standard can be held constant or can decline over time. Sources with emission rates below the standard can earn credits, while sources with rates above the standard must purchase credits for their excess emissions. This type of program works best for sources that have similar emissions characteristics. It could in theory be applied to off-road mobile sources by establishing emission rate standards for individual types of equipment, although the diversity of off-road equipment would make this challenging.

7.3 General Conformity Credits

The Clean Air Act prohibits federal actions that would contribute to the violation of a SIP. For ports and airports, this typically means that any construction project that involves use of federal funds or federal agency approval must not result in emissions that will exceed *de minimis* levels (which range from 10 to 100 tons of pollutant emissions per year). This demonstration of “general conformity” can be applied to any activity that involves federal action, such as wharf construction or the use of federal funds for airport expansion. Port projects subject to conformity determinations are most likely to be dredging projects, because they typically require a permit from the U.S. Army Corps of Engineers.

The general conformity regulations do not specifically allow agencies to receive credit for previous emission reduction measures at ports or airports. Consequently, ports and airports have reportedly been reluctant to implement control measures until required to do so by a SIP or until the reductions are needed for a conformity determination. The Federal Aviation Administration (FAA) has stated that the lack of emission credits has been a disincentive for airports to reduce emissions because voluntary reductions simply lower an airport’s emissions baseline. Therefore, an airport that has already reduced emissions has fewer options for producing more reductions for new airport development projects.⁵⁷

In the case of airports, however, EPA has recently issued guidance intended to allow emission reduction credits for voluntary early emission reduction programs.⁵⁸ By participating in such a program, airports have the opportunity to apply for federal grants to achieve early emission reductions that earn emission credits from state air quality agencies. Airports can use the emission credits on airport development projects at a later date to satisfy general conformity requirements.

A similar (but separate) credit program has been established by the Port of Seattle and the Puget Sound Clean Air Agency. The Port of Seattle owns and operates Seattle-Tacoma International Airport. The Port is currently implementing a master plan update, which calls for improvements at the airport to be undertaken through 2010. The Port recognized that the airport improvement projects would offer opportunities to reduce emissions beyond that required of the Port, but that there was no incentive to incur the additional costs to achieve emission reductions. The Port signed a memorandum of agreement (MOA) with the Puget Sound Clean Air Agency that ensures that the Port will receive credit for their voluntary actions if emission reductions are later required under the provisions of general conformity or Washington’s State Environmental Policy Act.⁵⁹ Although the MOA was established in response to airport construction activity, it could also apply to Port activity at seaport terminals.

⁵⁷ U.S. Environmental Protection Agency, *Guidance On Airport Emission Reduction Credits For Early Measures Through Voluntary Airport Low Emission Programs*, September 2004.

⁵⁸ U.S. Environmental Protection Agency, *Guidance On Airport Emission Reduction Credits For Early Measures Through Voluntary Airport Low Emission Programs*, September 2004.

⁵⁹ Available at <http://www.4cleanair.org/members/committee/mobile/RevisedMOA.pdf>

It appears that any air quality agency that has an emission reduction credit program could potentially establish an MOA similar to that between the Port of Seattle and the Puget Sound Clean Air Agency. There do not currently appear to be any other such agreements in place. The EPA guidance on general conformity emission reduction credits apply only to airports. EPA is expected to revise the general conformity regulations soon. Several federal agencies have requested that EPA include a provision in the revised regulations that specifically allows credit for emission reduction measures that are implemented before they are required for a general conformity determination.

There may be other opportunities to use the general conformity process to encourage emission reductions beyond those required under the Clean Air Act. In some instances, the general conformity provisions can discourage actions that would result in long-term emission reductions in the name of satisfying the short-term *de minimis* threshold. The Port of Oakland, for example, recently provided electric shore power to dredging vessels in order to satisfy general conformity requirements during the Port's 50-foot dredge project. After the project, however, these vessels returned to diesel-powered use in the San Francisco Bay Area. Had the general conformity process been structured differently, the Port might have invested in emission reduction technologies for the vessels and thereby provided long-term benefits to the region. This issue might also be addressed when EPA revises the general conformity regulations.

7.4 Supplemental Environmental Projects

When EPA pursues enforcement of federal environmental laws, such as the Clean Air Act, the agency usually requires violators to pay cash penalties and take steps to eliminate the noncompliance or correct the environmental damage. In addition, enforcement settlements may include Supplemental Environmental Projects (SEPs). SEPs are environmentally beneficial projects that a violator is not otherwise legally required to perform, but voluntarily agrees to undertake in settlement of enforcement action.

SEPs have existed since the early 1980s, but have been used more frequently in recent years. EPA issued guidance on the use of SEPs in the May 1998 SEP Policy.⁶⁰ To be approved as a SEP, a project must meet the following criteria:

- Have a "nexus" to the underlying violation
- Provide significant environmental and public health benefits
- Benefit the community affected by the violation
- Secure public health and/or environmental improvements beyond what can be achieved under applicable environmental laws

SEPs have been used to reduce emissions from in-use diesel engines. One notable example is EPA's March 2003 settlement with Toyota Motor Corporation. Through this SEP, Toyota will spend \$20 million to retrofit an estimated 2,500 diesel school buses, focusing on buses with higher emission rates and high use. The buses will be retrofitted with diesel particulate filters. These retrofits, along with the purchase of ULSD, are expected to eliminate 29 tons of PM emissions, 109 tons of HC emissions, and 294 tons of CO emissions.

In addition to the federal level, SEPs have also been successfully applied on the state and regional level. Two notable SEPs, totaling over \$1.5 million, were the result of enforcements in the State of Connecticut, with funds being allocated to retrofit school buses in three major Connecticut towns.

⁶⁰ EPA Supplemental Environmental Projects Policy, Effective May 1, 1998.

When EPA or a state agency is pursuing enforcement against violators of an environmental law, SEPs may offer a unique opportunity to reduce diesel emissions. Companies undertaking a SEP may benefit by receiving a reduced penalty from EPA or the state agency. Companies can also help to build better relations in their communities by going beyond the legally mandated compliance actions and improving quality of life in the community.

7.5 Qualship 21 Program

The U.S. Coast Guard offers to reduce the frequency of vessel safety inspections for ships that demonstrate a quality track record. Called “Qualship 21,” the program was initiated in 2001 and to date has certified more than 800 vessels. Requirements for Qualship 21 participation include:

- No substandard vessel detention in the U.S. within the previous 36 months
- No marine violations or serious marine casualties and no more than one ticket in U.S. within the previous 36 months
- Not owned or operated by any company that has been associated with any port state control (PSC) detention in U.S. waters within the previous 24 months
- Not registered with a flag country that has a detention ratio greater than or equal to 1.0 percent
- Vessel’s flag country must have submitted their Self-Assessment of Flag State Performance to the IMO and provided a copy to the U.S. Coast Guard

Ships holding a Qualship 21 certificate are rewarded with reductions in Coast Guard examinations and streamlined inspection procedures. The Port of Houston Authority is currently holding discussions with the Coast Guard, EPA Region 6, TCEQ, and the Houston-Galveston Area Council about establishing an air quality component to the Qualship 21 program in the Houston region. One option under consideration is to provide incentives for vessels to comply with the MARPOL Annex VI NO_x emission standards. Vessels that meet the Annex VI standards could be rewarded with a reduction in inspection frequency or a reduction in port fees (see Section 7.6).

7.6 Differentiated Port Fees

Several European countries vary the fees imposed for use of a port or channel based on emissions or other measures of environmental performance. While this type of incentive has not yet been implemented in the U.S., it is of particular interest because it offers one of the few options for influencing emissions from foreign-flagged marine vessels. Most oceangoing vessels calling on U.S. ports are owned and operated by foreign entities and thus not typically eligible to receive grants or tax incentives offered by government agencies in the U.S.

A coalition of environmental groups is supporting a graduated harbor fee or container fee system for California ports. The fees would be based on the amount of pollution generated by the ship, possibly involving discounts for ships that employ emission reduction strategies. The environmental groups suggest that the fees be used to create a dedicated source of funding for port diesel emission reduction projects. Such an incentive program might also award cleaner ships with a higher priority for docking during congested periods.

Swedish Port Fee Incentive Program

The most notable example of differentiated port fees based on emissions occurs in Sweden. Since 1998, some Swedish ports have chosen to participate in a program to reduce emissions using differentiated port

fees that is based on an agreement reached between the Swedish Maritime Administration, the Swedish Shipowners' Association, and the Swedish Ports' and Stevedores' Association.⁶¹

The system is intended to be revenue-neutral, so reduced fees for some vessels are offset by higher charges for others. Fees are reduced for vessels using bunker fuel with lower sulfur content (less than 0.5 percent for passenger ships and less than 1.0 percent for other vessels). Fees are further reduced based on vessel emission rates. Any vessel with NO_x emissions less than 12 grams per kilowatt-hour (g/kW-hr) can receive a fee reduction, with the reduction increasing linearly down to 2 g/kW-hr. In total, the cleanest vessels can achieve as much as a 50 percent reduction in fees.

The program appears to be successful in promoting the use of low sulfur bunker fuels. In 2000, more than 1,400 vessels in Swedish waters were using low sulfur fuel, most using fuels in the range of 0.5 to 0.9 percent sulfur. These vessels represent the majority of vessels calling on Swedish ports. Fewer vessels had obtained fee reductions based on NO_x emission rates, apparently due to the cost of the improvements. In 2000, 21 vessels in Swedish waters had invested in the equipment necessary to gain a fee reduction based on NO_x emissions, although 30 more were in the process of applying for the reduction in that year. To help defray costs, the Swedish Maritime Administration offered, for a time, to cover some of the costs for vessels being retrofitted for NO_x reductions. These payments were as high as 40 percent of the retrofit cost before 2000, and 30 percent in 2000 and 2001.

Other European Port Fee Incentive Programs

Differentiated port fees have been proposed or implemented in several other European countries as a way to promote marine emission reductions.⁶² Norway proposed a scheme in 1999 that would vary business taxes on Norwegian ship owners based on environmental performance. Each ship would be scored based on seven criteria, including air emissions of NO_x and SO_x. Vessels that score the highest would pay reduced taxes; those that score low or elect not to participate would pay the full business tax. Because the business tax on ship owners is relatively small, the monetary incentive of this program would likely have only limited effect. However, it was hoped that the education and recognition associated with the program would induce ship owners to invest in emission reduction improvements.

The Port of Mariehamn, Finland, offers port fee rebates to vessels with lower NO_x emissions and those using low sulfur bunker fuels. Ships with NO_x emissions less than 10 g/kW-hr can receive the rebate, which starts at 1 percent of fees (at 9 g NO_x/kW-hr) and increases linearly to 8 percent of fees (at 1 g NO_x/kW-hr). Vessels using bunker fuels with less than 0.5 percent sulfur receive a 4 percent rebate, and those with lower NO_x emissions and low sulfur fuels receive an additional rebate. The maximum rebate is 20 percent of port fees.

The Green Award Foundation is an independent foundation based in the Netherlands that certifies ships for superior environmental performance.⁶³ A number of ports offer fee reductions to these vessels (typically 3 to 6 percent), including ports in the Netherlands, Lithuania, Spain, Portugal, South Africa, and New Zealand. Approximately 165 vessels, belonging to 35 ship owners, have been certified to date. The certification requirements relate to general environmental management and safety processes and do not consider air emissions. Nonetheless, such a voluntary program could conceivably be adapted to include emission reductions as a certification criterion.

⁶¹ Information in this section based on: BMT Fleet Technology Limited, *Management Options for Marine Vessel Emissions*, Prepared for Environment Canada, Pacific and Yukon Region, June 2004.

⁶² Information in this section based on: BMT Fleet Technology Limited, *Management Options for Marine Vessel Emissions*, Prepared for Environment Canada, Pacific and Yukon Region, June 2004.

⁶³ See www.greenaward.org

The Port of Hamburg implemented a “Green Shipping” incentive scheme from 2001 to 2003. Vessels calling on the port were offered a fee reduction of 6 percent if the ship owner was ISO 14001 certified (see Section 6.2) or the ship had been certified with a Green Award (described above). A fee reduction of 12 percent was awarded for ships using bunker fuel with less than 1.5 percent sulfur or using anti-fouling paints without the toxic additive tributyltin (TBT). More than 3,500 ships were awarded the rebates, most for use of TBT-free paints. In part because vessel paints containing TBT were banned in Europe in 2003, the program was discontinued.

No U.S. port is known to offer reduced fees based on vessel environmental performance. As mentioned in Section 7.5, the Port of Houston Authority is working with the Coast Guard to explore the possibility of participation in the Qualship 21 Program as a means to certify voluntary compliance with the MARPOL Annex VI NOx standards and possibly offer fee reductions in return.

7.7 Building Permit Fee Rebates

Local governments could offer building permit fee rebates to construction companies as an incentive to implement emission reduction measures. Construction companies are typically required to obtain a variety of permits from a city or county in the course of building construction. A local government could establish a program that offers reduced permit fees if construction companies take steps to reduce emissions from the equipment they use on the project.

This type of program has been used in the home building sector to promote radon gas-resistant construction. In areas where radon, a naturally occurring gas, is a particular concern due to locally high levels, home builders often employ relatively low-cost techniques to minimize radon levels in new homes. If these measures are not required, however, builders may need incentives to implement the measures. Some local governments provide rebates for building or sewer permits if new homes are constructed to resist radon.

We have not identified any existing examples of a construction permit rebate program for diesel emission reduction. Such a program would be relatively easy to establish and administer. The local government would need to identify the emission reduction measures that qualify for rebates and then promote the program among construction companies. The program would likely require high-level approval within the city or county, because one department (building permits) would be foregoing revenue in exchange for environmental and public health benefits to residents. This type of program could also be coupled with some type of voluntary recognition, whereby participating companies could identify themselves or their project as “clean” and potentially gain market advantage.

7.8 Summary of Findings on Other Types of Incentives

In addition to the four major categories of incentives discussed in Sections 3 – 6, several other types of incentives may be effective at promoting reductions in emissions from off-road diesel port and construction equipment. Many of these incentives are limited to a small number of companies or face significant barriers to implementation.

SIP credits are an incentive inherent to the Clean Air Act and apply to all state air quality agencies with areas in violation of national air quality standards. Voluntary Mobile Source Emission Reduction Programs (VMEPs) rely on the voluntary actions of individuals or businesses to achieve emission reductions and offer more flexibility than traditional SIP control measures.

Mobile source emission reduction credits (MERCs) are generated when a company reduces transportation emissions beyond what is required and sells the credits to other companies covered by a tradable permit system. Emission reduction credits are generated and traded regularly among stationary emission sources such as power plants under several tradable permits systems currently operating in the U.S. and other countries. In theory, MERCs can provide an incentive for construction companies or port terminal operators to voluntarily reduce emissions from off-road diesel equipment, and some states and regions (most notably the South Coast Air Quality Management District) have taken steps to specifically encourage generation of MERCs for off-road diesel sources. To date, however, MERCs have proven impractical because of the costs associated with quantifying and certifying the emission reductions.

Air quality agencies and port authorities can enter into agreements that provide the port with emission reduction credits for voluntary implementation of emission reduction measures. These credits can be applied to satisfy the provisions of the Clean Air Act general conformity regulations or possibly state environmental regulations. Such an agreement provides an incentive for ports to adopt emission reduction measures during construction projects before they would otherwise be required to do so. EPA is currently revising the general conformity regulations, which may result in other types of incentives to reduce emissions from off-road diesel engines through the general conformity process.

Supplemental Environmental Projects (SEPs) are environmentally beneficial projects that a violator is not otherwise legally required to perform, but voluntarily agrees to undertake in settlement of enforcement action. The benefits of a SEP must go to the community affected by the violation. SEPs have existed since the early 1980s but have been used more frequently in recent years. One notable example is EPA's March 2003 settlement with Toyota Motor Corporation, which resulted in a SEP through which Toyota will spend \$20 million to retrofit an estimated 2,500 diesel school buses. As an incentive, SEPs apply only to companies that have violated federal environmental laws.

Another potential mechanism or model for regulatory flexibility is the U.S. Coast Guard's Qualship 21 program, which offers to reduce the frequency of vessel safety inspections for ships that demonstrate a quality track record. One option (under consideration at the Port of Houston Authority) is to use the Qualship 21 platform to reward vessels to comply with the MARPOL Annex VI NO_x emission standards with a reduction in inspection frequency or a reduction in port fees.

Differentiated port fees could be used to promote low sulfur bunker fuels or other emission reductions technologies on ships. This type of incentive is currently offered in Sweden and several ports in Finland, and the results appear promising. There have also been several voluntary "green shipping" initiatives in Europe that reward vessels demonstrating superior environmental and safety performance with port fee reductions. This type of incentive is one of the few opportunities to influence emissions from oceangoing marine vessels, most of which are not U.S.-owned.

Rebates on building permit fees could be offered by local governments as an incentive to encourage construction companies to implement emission reduction measures on their equipment for building construction projects. While we have not identified any examples of this type of program in the building construction sector, it would likely be relatively easy to establish and administer.

8 SUMMARY AND CONCLUSIONS

The experiences of state and local agencies and port authorities in promoting diesel emission reductions over the last decade offer some valuable lessons for those developing new incentive programs. State and local governments generally have little authority to regulate emission rates from mobile sources. As the aggressive EPA emission standards for on-road diesel vehicle take effect, the contribution of off-road diesel sources to regional air quality problems is becoming more prominent. A number of state and local agencies are struggling to control emissions from these sources and seeking effective incentive programs.

Monetary grants appear to be the most favored type of incentive among equipment owners and public agencies alike, based on the interviews conducted for this study. The technological options for reducing off-road emissions require investment, and while some result in lower operating costs, they do not pay for themselves in operating cost savings. Marine shipping and construction are both highly competitive industries, and few entities are able to shoulder the additional expense of emission reduction technologies without some compensation. Most grant programs provide equipment owners with the flexibility they need to make their own decisions about how to reduce emissions in a cost-effective, practical manner. Grants can be structured to target emission reductions where they are needed most. The two major statewide grant programs (Moyer and TERP) have been highly successful in achieving off-road diesel emission reductions and deserve replication elsewhere. However, grant programs require substantial amounts of staff time and resources to administer, as well as dedicated funding, which clearly limits the ability of some agencies to offer grants.

Tax incentives have some advantages relative to grants, but generally have not been used to promote diesel emission reductions. Terminal operators and some construction industry stakeholders have expressed strong interest in the concept of tax incentives as a way to promote diesel emission reduction strategies. To be effective, tax incentives need to be large enough to cover the incremental cost of emission reduction technology; the few examples in place appear to be too small to induce private sector action. An advantage of a tax incentive is that it is available all the time (no application deadline) and is not subject to exhaustion of funds. Tax incentives may not be useful to companies that make little profit and, thus, have little tax liability. It can be difficult to use tax incentives to target a particular location or source where emission reductions are most needed. Rather than tax credits, the construction community would prefer a federal tax deduction that allows firms to write-off immediately or expense the cost of purchasing and installing diesel retrofit equipment.

Contracting provides an enforceable mechanism for state and local governments to reduce diesel emissions on public works projects or, alternatively, provide grants through the contracting process. **Contract specifications** stipulate emission reduction technology as part of a contract's terms and conditions. This mechanism appears to be growing in popularity following several high profile examples, including Massachusetts' Big Dig and Connecticut's Q Bridge I-95 project. The nation's most extensive effort to use contract specifications for diesel retrofits is occurring in New York City, where Local Law No. 77 will soon require use of ULSD and "best available technology" for emission control in all diesel-powered off-road equipment used in city construction projects. Environmental groups strongly support this approach to diesel emission reduction.

Contract specifications place the financial burden of purchasing emission reduction technologies on the equipment owners, most of whom will eventually need to recover those costs through higher service fees. The proliferation of contract specifications is a major concern to the contracting community for several reasons. Small contracting companies may not have the ability to finance the equipment upgrades necessary to win work under a contract specification. If implemented widely in a particular region,

contract specifications could shrink the market for a construction company with a fleet of older diesel equipment, which would devalue the company's assets. Construction companies are also concerned that contract specifications might adversely affect a company's financial statement, limiting its ability to borrow money and secure bonding for future projects.

Contract allowances incorporate a payment to the contractor to fully or partially offset cost of emission reduction investments. A contract allowance can be structured like a contract specification paired with a grant to the winning bidder (e.g., the emission reductions are required), or can merely provide optional incentives to encourage the contractor to invest in emission reduction technologies. When paired with contract specifications, contract allowances may provide a mechanism to help level the playing field for small contractors who cannot finance investments in emission reduction technologies. Although contract allowances are reportedly under consideration in several places, the City of Atlanta and the Texas Department of Transportation appear to be the only government agencies that have actually tried this mechanism. These programs have just been implemented, and it is too soon to assess their success.

Similar to contract specifications, port authorities can stipulate emission reduction technologies or operations in a lease agreement with a marine terminal operator. The only such example of **port lease specifications** to date is at the Port of Los Angeles, where the Port is requiring measures such as vessel electrification (cold ironing), retrofits on yard tractors, and use of emulsified fuel in cargo handling equipment. This mechanism appears unlikely to spread widely outside Southern California in the near term, because most ports are hesitant to stipulate diesel emission reductions in a lease for fear it would harm their competitive position. The effectiveness of lease specifications in achieving port-wide emission reductions is hindered by the long leases at many terminals and, thus, infrequent opportunities to negotiate new lease terms.

Some non-monetary incentives can encourage owners of off-road diesel equipment to reduce emissions in the name of **environmental stewardship** or **improving operational efficiency**. Adoption of an EMS, for example, provides a framework to integrate environmental decision-making into an organization's day-to-day operations, making it easier to find and fix the root causes of potential environmental problems. While development and implementation of an EMS entails some upfront costs, organizations with an EMS benefit on many fronts, including improved community relations and public image, better internal communication, and long-term cost savings. Improving the operational efficiency of ports and construction activities often results in lower fuel use and emissions. These types of incentives can vary widely in effectiveness and ease of participation. They are typically easily transferable between jurisdictions or agencies and have little impact on small business competitiveness. Government agencies can encourage environmental stewardship by providing public recognition, educational information about opportunities to reduce emissions or improve efficiency, and guidance on voluntary actions to assess current emissions and plan for improvements; they can also act as a facilitator to create opportunities for information exchange and leverage additional funding.

SIP credits are one of the primary factors motivating state and regional air quality agencies to seek diesel emission reductions. Voluntary industry actions to reduce diesel emissions may be well suited to SIP credit as a Voluntary Mobile Source Emission Reduction Program (VMERP). **Mobile source emission reduction credits** (MERCs) have, to date, proven impractical because of the high certification costs, although MERCs appear to have potential for greater use in the off-road diesel sector. **General conformity credits** could provide an incentive for ports to take early action to reduce diesel emissions by ensuring that the port can later use the emission reductions to satisfy general conformity requirements during construction. For companies that have violated federal environmental laws, **Supplemental Environmental Projects** offer an incentive to reduce emissions beyond legally mandated compliance actions, with the benefits going to the community affected by the violation. The **Coast Guard's Qualship 21 program** might be a mechanism to provide incentives for vessels to comply with the MARPOL

Annex VI emission standards. **Differentiated port fees** could be used to promote low sulfur bunker fuels or other emission reduction technologies on ships, as currently occurs in several European nations. This incentive is one of the few opportunities to influence emissions from oceangoing marine vessels, most of which are not U.S.-owned. Finally, **building permit fee rebates** could be offered by local governments as an incentive for construction companies to reduce diesel emissions during building construction projects.

Clearly, no single type of incentive offers the solution to the off-road diesel emissions problem. An effective approach to curbing emissions from in-use construction and marine terminal equipment will depend on a combination of incentives, including grants, tax incentives, contracting procedures, and non-monetary incentives. A number of potential incentive programs may, in fact, work best when paired with other types of incentives. For example, a tax incentive or contract allowance paired with a contract specification could provide both a “carrot” and a “stick” to the construction industry in a particular region. Grant programs could be more effective when coupled with non-monetary incentives that encourage environmental stewardship. And a building permit fee rebate program would work best if offered in conjunction with public recognition for participants.

APPENDIX A – EPA EMISSION STANDARDS

EPA Non-Road Diesel Equipment Emission Standards

Engine Power	Tier	Starting Model Year	Emission Standards (g/bhp-hr)			
			NMHC+NOx	NOx	CO	PM
hp < 11	1	2000	7.8		6.0	0.75
	2	2005	5.6		6.0	0.60
11 ≤ hp < 25	1	2000	7.1		4.9	0.60
	2	2005	5.6		4.9	0.60
hp < 25	4	2008	5.6			0.3
25 ≤ hp < 50	1	1999	7.1		4.1	0.60
	2	2004	5.6		4.1	0.45
25 ≤ hp < 75	4	2013	3.5			0.02
50 ≤ hp < 100	2	2004	5.6		3.7	0.30
	3	2008	3.5		3.7	0.30
100 ≤ hp < 175	2	2003	4.9		3.7	0.22
	3	2007	3.0		3.7	0.22
75 ≤ hp < 175	4	2012		0.3		0.01
175 ≤ hp < 300	2	2003	4.9		2.6	0.15
	3	2006	3.0		2.6	0.15
300 ≤ hp < 600	2	2001	4.8		2.6	0.15
	3	2006	3.0		2.6	0.15
600 ≤ hp < 750	2	2002	4.8		2.6	0.15
	3	2006	3.0		2.6	0.15
175 ≤ hp < 750	4	2011		0.3		0.01
hp > 750	2	2006	4.8		2.6	0.15
	4	2011 (gensets>1200 hp)		0.5		0.075
	4	2011 (all others)		2.6		0.075
	4	2015 (all gensets)		0.5		0.02
	4	2015 (all others)		2.6		0.03

EPA Marine Vessel Compression Ignition Emission Standards

Engine Category	Power	Displacement	Year	Emission Standards (g/kW-hr)		
				HC+NOx	PM	CO
Category 1	kW > 37	L/cy < 0.9	2005+	7.5	0.4	5.0
		0.9 < L/cy < 1.2	2004+	7.2	0.3	5.0
		1.2 < L/cy < 2.5	2004+	7.2	0.2	5.0
		2.5 < L/cy < 5.0	2007+	7.2	0.2	5.0
Category 2	kW < 3300	All Cat. 2	2004-06	IMO stds	-	-
		5.0 < L/cy < 15	2007+	7.8	0.27	5.0
		15 < L/cy < 20	2007+	8.7	0.5	5.0
		15 < L/cy < 20	2007+	9.8	0.5	5.0
		20 < L/cy < 25	2007+	9.8	0.5	5.0
		25 < L/cy < 30	2007+	11.0	0.5	5.0
Category 3		L/cy > 30	2004+	IMO stds	-	-

Note: IMO standards are defined as follows:

if rpm > 2000	NOx = 9.8 g/kW-hr
if 130 < rpm < 2000	NOx = 45 x rpm ^(-0.2) g/kW-hr
if rpm < 130	NOx = 17 g/kW-hr

Source: "Marine Diesel Engine Emission Control Programs," presentation by Jean Marie Revelt, U.S. EPA, January 29, 2004.

EPA Diesel Locomotive Emission Standards

	Emission Standards (g/bhp-hr)	
	NOx	PM-10
Tier 0 (1973 – 2001 model years)		
Line-haul duty-cycle	9.5	0.60
Switch duty-cycle	14.0	0.72
Tier 1 (2002 – 2004 model years)		
Line-haul duty-cycle	7.4	0.45
Switch duty-cycle	11.0	0.54
Tier 2 (2005 and later model years)		
Line-haul duty-cycle	5.5	0.20
Switch duty-cycle	8.1	0.24

EPA Heavy-Duty Diesel Vehicle Emission Standards (On-Road Trucks)

Model Year	Emission Standards (g/bhp-hr)			
	HC	CO	NOx	PM
1974-78 ^a	-	40	-	-
1979-83 ^b	1.5	25	-	-
1984-87	1.3	15.5	10.7	-
1988-89	1.3	15.5	10.7	0.6
1990	1.3	15.5	6	0.6
1991-93	1.3	15.5	5	0.25
1994-97	1.3	15.5	5	0.1
1998-2003	1.3	15.5	4	0.1
2004-2006 ^{c, d}	0.5	15.5	2	0.1
2007+ ^e	0.14	15.5	0.2	0.01

Notes: (a): Combined HC+NOx standard of 16 g/bhp-hr; (b) Combined HC+NOx standard of 10 g/bhp-hr; (c) Under a consent decree with U.S. EPA, engine makers implemented the 2004 standards in October 2002; (d) Standards allow the option of 2.4 g/bhp-hr non-methane hydrocarbons (NMHC)+NOx, or 2.5 g/bhp-hr NMHC+NOx and 0.5 NMHC; (e) Standards phased in between 2007 and 2010 on a percent-of-sales basis – 50% from 2007 to 2009 and 100% in 2010.