# Evaluation of Port Trucks and Possible Mitigation Strategies

## Executive Summary

### Background

This report presents an analysis of the air quality impacts and the potential options for reducing emissions in a cost effective manner from on-road heavy duty diesel trucks dedicated to goods movement at California ports. Air Resources Board (ARB) staff estimates that approximately 12,000 on-road heavy duty trucks routinely transport containerized and bulk cargo to and from California's three largest ports.

The Ports of Long Beach, Los Angeles, and Oakland are ranked as some of the largest ports in the world. Air pollution from port activities is a significant and growing concern. Diesel-fueled engines powering vehicles and equipment at the ports emit diesel particulate matter (PM) and other pollutants that increase health risks to nearby residents. Port operations are also a significant source of oxides of nitrogen (NOx) which contributes to the formation of regional smog, or ozone, and fine particulate matter.

Living in communities significantly impacted by air pollution causes adverse health effects, particularly for children, the elderly, and those with compromised health. The communities closest to the ports, adjacent to heavily traveled freeways, and near rail facilities are subjected to even greater impacts and have a greater localized risk due to exposures to unacceptably high levels of diesel PM. Diesel PM poses a lung cancer hazard and causes respiratory and cardiovascular health effects that increase the risk of premature death.

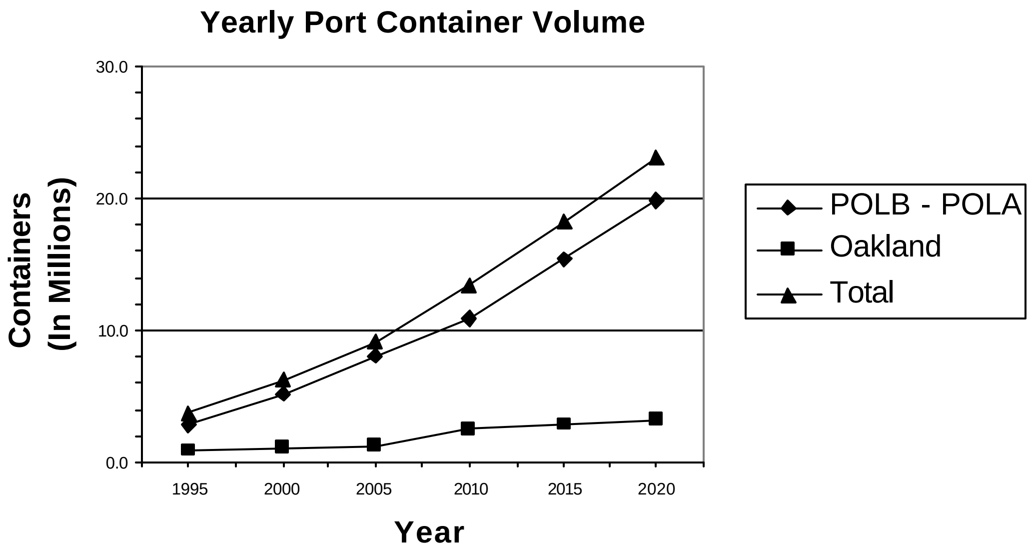
### Goods Movement

Virtually all seaborne containerized goods in California enter through the Ports of Oakland, Long Beach (POLB), and Los Angeles (POLA). Combined, the container volume at the three ports was approximately 9.3 million in 2005. The largest ports in California are, by far, the Ports of Los Angeles and Long Beach. These ports are located adjacent to each other in Southern California and account for approximately 87 percent of total yearly State container volume. The Port of Oakland is the third largest port in California with a yearly volume of approximately 1.3 million containers. Other ports in California, such as San Diego and Stockton, generate volumes of less than 42,000 containers yearly.

The movement of this container freight through California ports is a vital component of the State's trade oriented economy and provides a key link to international goods, both for California and much of the rest of the United States of America. Trade is expected to increase significantly by 2020. Container volume is projected to increase to

23.1 million containers annually by 2020. Figure 1 shows expected container growth at the Ports of Long Beach, Los Angeles, and Oakland from 1995 through 2020.

**Figure 1: Actual 1995 – 2004 and Estimated 2005 and Later Yearly Port Container Volume**




Loaded with every imaginable product, containers are standard sized 'boxes' of either 20 foot or 40 to 53 foot lengths. Loaded containers are transported via ship from a port of origin (e.g. Hong Kong) and delivered to ports around the world. Once at a destination port, the containers are offloaded from the ship and transported to a final destination by truck or train. Once empty, the containers are then either reloaded or transported empty to a new destination to start the cycle over again. At California's two largest ports, Los Angeles and Long Beach, approximately 75 percent of all in bound containers are transported by on-road heavy-duty diesel trucks from the terminals. The remaining 25 percent are transferred via yard hostler to rail staging areas on port property for later train transportation. Rail facilities at the Port of Oakland are located just outside the port properties. On-road heavy-duty diesel trucks are used to transport ship borne containers from the port to rail facilities. On average, approximately 35 percent of the port trucks in Oakland are used in this capacity.

In addition to containerized cargo, bulk cargo such as grain or gypsum, which are typically transported within the hold of a ship, may also utilize heavy-duty diesel trucks for transportation. After arriving at the port, bulk cargo is either offloaded from trucks, or loaded on to trucks for shipment inland or moved directly into manufacturing facilities located at the ports. Trucks that transport bulk cargo are a relatively minor part of port truck traffic, and account for roughly 4 percent of the trucks operating in the ports.

## Port Trucks and Economics

The California container goods movement industry utilizes large class 8[1] heavy-duty diesel-fueled vehicles (HDDV) with maximum capacities up to 80,000 pounds (truck and cargo).[2] Trucks that operate at the ports for local or regional service are typically older models with high mileage and are generally much older than trucks used for long haul activities. After an HDDV vehicle accumulates 500,000 – 750,000 miles, it approaches the end of its useful life as a long-haul truck. Often, the truck is auctioned or sold to an owner that may utilize the vehicle for purposes other than long-haul activities, such as transporting containers.

Most port trucks are driven by owner/operators in an economically competitive business that generates low profit margins with little ability to increase rates to cover the costs of complying with potential emission reduction strategies. Port truck owners arrange for business through dispatching companies, which in turn, contract with port terminals to transport containers or bulk cargo.

Considering annual operating costs, such as fuel, maintenance, and mandated fees, truck drivers' annual pre-tax net earnings, which are essentially their wages, appear to average about $30,000. The low wages and difficult working conditions experienced by port truck owner/operators limits the supply of available port trucks to haul containers.

## Emissions and Health Risks

Port truck activities generate approximately 7,075 tons per year (TPY) of NOx and 564 tons[3] per year of diesel PM in 2005. These emissions represent 23 percent of all port-related NOx emissions and nine percent of all port-related diesel PM emissions. Table 1 lists the emissions of diesel PM and NOx for the Ports of Long Beach, Los Angeles, and Oakland. Mitigating port truck emissions to the greatest extent possible will help lessen the harmful effects of pollution on the surrounding population centers.

[1] Class 8 vehicles are defined as having a gross vehicle weight of 33,001 lbs and over
[2] California Vehicle Code 35551, http://www.dmv.ca.gov/pubs/vctop/d15/vc35551.htm
[3] Calculations for emissions are explained in the Emissions section of this report.

**Table 1: Estimated 2005 Port Truck Emissions for the Ports of Los Angeles, Long Beach and Oakland (rounded)**

| PORT | PM (TPY) | NOx (TPY) |
|---|---|---|
| Port of Long Beach (POLB) Port of Los Angeles (POLA) (including regional on-road) | 491 | 6,048 |
| Port of Oakland (including regional on-road) | 73 | 1,027 |
| **Total** | **564** | **7,075** |

The Ports of Long Beach, Los Angeles, and Oakland are located adjacent to population centers. These communities have imbedded major traffic arteries that provide access to the ports. On a typical weekday, approximately 10,000 individual trucks make an estimated 2-3 trips each, either to or from the Ports of Los Angeles and Long Beach principally along the 110 and 710 freeways. In addition, 2,000 trucks travel to the port of Oakland an average of 2-3 times each day. Traffic conditions along the major thoroughfares into the ports are often congested, and the fleet of older, or high polluting trucks result in high levels of exposure to diesel PM in adjacent communities. Emissions and resulting risk are expected to increase with the expected growth in trade unless substantial additional control measures are implemented to reduce port related emissions.

**Emission Reduction Strategies**

Emissions reductions from port trucks can be obtained by fleet modernization through the installation of diesel particulate filters (DPFs), oxidation catalysts, NOx reduction technologies, or possibly through the use of other verified strategies. These technologies represent varying degrees of effectiveness for PM control and their application, especially with DPFs, can be limited. Replacement of older higher emitting engines with newer cleaner emitting engines by repowering or replacing the existing truck is the most effective strategy, although significantly more expensive, for reducing both PM and NOx emissions.

In 2002, ARB staff estimates that approximately 72 percent of port trucks are model year 1993 or older and operate using older, higher PM and NOx emitting engines. Furthermore, only 28 percent of the existing port truck fleet was new enough (truck model year 1994 and newer) to support retrofit with a DPF for PM control.

In evaluating strategies, ARB staff sought to maximize early diesel PM reductions, create significant NOx reductions, and maintain cost effectiveness with the goal of modernizing and/or retrofitting the entire port truck fleet of approximately 12,000 vehicles. The three strategies presented in this report share three common goals. The first is to install DPFs on all trucks that routinely visit the ports to ensure maximum and timely PM reductions. We estimate this measure alone will reduce diesel PM emissions by 85 percent or better on vehicles that have been upgraded. The second goal is to modernize the fleet using truck replacements that provide for the purchase of much less expensive depreciated used trucks in a way that enables retrofit of DPFs and achieves lower NOx emissions. Regardless of which strategy is implemented, trucks that are taken out of service and replaced should be scrapped to ensure emission reductions are permanent and the trucks are not introduced into another line of service. The third is to establish a regulatory or other equally enforceable program to implement minimum requirements for bringing additional trucks into port service and to ensure that emissions reductions obtained through retrofit or replacement are not eroded by the use of older, dirtier trucks, as the need for more trucks occurs.

Under this approach, drivers entering port service starting after the measure is established would be required to use trucks meeting cleaner truck requirements based on the year the truck would be brought into port service. It is envisioned that, from program start through 2011, any truck brought into port service would have to meet 2003 model year (MY) or later standards, and be equipped with a DPF. Starting in 2012 and through 2014, trucks brought into port service would need to meet 2007 MY or later standards. For 2015 and beyond, only trucks meeting 2010 MY and later standards would be allowed. Establishing requirements for new trucks entering port service ensures that all vehicles used to handle expected growth at California ports meet very stringent PM standards and meet progressively lower NOx standards. With these measures in place, port trucks would, in the 2010 through 2020 period, be among the cleanest fleets in the State.

Three separate strategies were analyzed to reduce emissions of NOx and PM from the existing port truck fleet. Strategy 1 puts the highest priority on reducing diesel PM emissions by replacing model year 1993 and older trucks with 1998 and newer model year trucks and equipping the entire fleet with DPFs over a 2007-2010 implementation period. The use and installation of DPFs would reduce diesel PM emissions by 85 percent or more. These filters are widely available for installation on model year 1994 and later trucks. Additionally, replacing older, higher NOx emitting trucks with 1998 or newer model year trucks would generate some amount of fleet wide NOx reductions after full implementation in 2010.

Strategy 2 combines a high level of diesel PM reduction with a substantial reduction in NOx by replacing model year 2002 and older trucks with newer 2003 to 2006 model year trucks. Similar to strategy 1, all trucks operating at the ports will be equipped with a DPF that achieves an 85 percent PM reduction. Substantial NOx reductions would be achieved through replacing all pre-2003 MY trucks with 2003-2006 MY trucks, which corresponds to the first year of the 2003 NOx + HC engine standard of 2.5 g/bhp-h. Replacing the older, higher NOx emitting (4 g/bhp-h and higher) trucks with newer model year 2003 trucks would generate substantial fleet wide NOx reductions after full implementation in 2010.

The third strategy also seeks a high level of NOx control and consists of two phases. The first phase would replace pre-1994 trucks with 1998-2002 trucks that meet at least a 4.0 g/bhp-h NOx certification standard. These trucks, along with existing 1994-2002 trucks, would be retrofitted with NOx/DPF control combination to achieve 85 percent or better PM control and 25 percent or better NOx control. Existing 2003 MY and later trucks would be retrofitted with DPFs. The second phase would require the retirement or replacement of the 1994 through 2002 trucks by 2017. In order for drivers to continue to work in port services, these trucks would have to be replaced with 2010 MY or later trucks. The remaining 2003 through 2006 trucks would need to be replaced with 2010 MY or later trucks by 2019. This strategy provides most of the short term NOx reductions obtained through strategy 2; however, it provides much greater long term NOx benefits, and does so at a much lower cost.

Additionally, all three strategies would be combined with a regulatory or other enforceable program that imposes stringent PM and progressively tighter NOx requirements on new entrants to the port truck fleet. Table 2 summarizes the cost effectiveness for all three strategies.

**Table 2: Costs, Emission Reductions, and Cost Effectiveness over Capital Recovery Period (10 Years)**

| Strategy | Cost (2005) (Millions) | Emission Reductions (Cumulative TPY) | | Average Annual Cost Effectiveness ($/Ton) | | |
|---|---|---|---|---|---|---|
| | | PM | NOx | PM | NOx | Moyer[4] |
| Strategy 1 Existing Fleet | $180 | 5,000 | 4,800 | $37,000 | $8,000 | $4,500 |
| Strategy 2 Existing Fleet | $570 | 5,300 | 23,000 | $35,000 | $17,000 | $11,800 |
| Strategy 3 Existing Fleet | $280 | 5,200 | 20,000 | $28,000 | $7,000 | $5,900 |
| Strategy 3 Phase 2 | $200 | | 47,500 | | $4,000 | |
| Trucks Entering Port Service | $110 | 1,200 | 15,300 | $34,000 | $5,000 | |

Figures 2 and 3 summarize existing fleet baseline PM and NOx emissions and emission reductions in 2010, 2015, and 2020 for each of the three strategies. PM emission reductions (Figure 2) are expected to be virtually identical after 2010, as all strategies will effectively require DPF retrofits or 2007 MY trucks (with DPFs). Strategies 1 and 2 NOx emissions (Figure 3) are expected to increase as the fleet ages after 2010.

[4] See Appendix B for Cost Effectiveness using Carl Moyer Methodology

Conversely, as strategy 3 requires additional fleet upgrades in 2017 and 2019, long-term NOx emission benefits are expected to be greater.

**Figure 2: Comparison of PM Emissions for the Period 2005 – 2020**

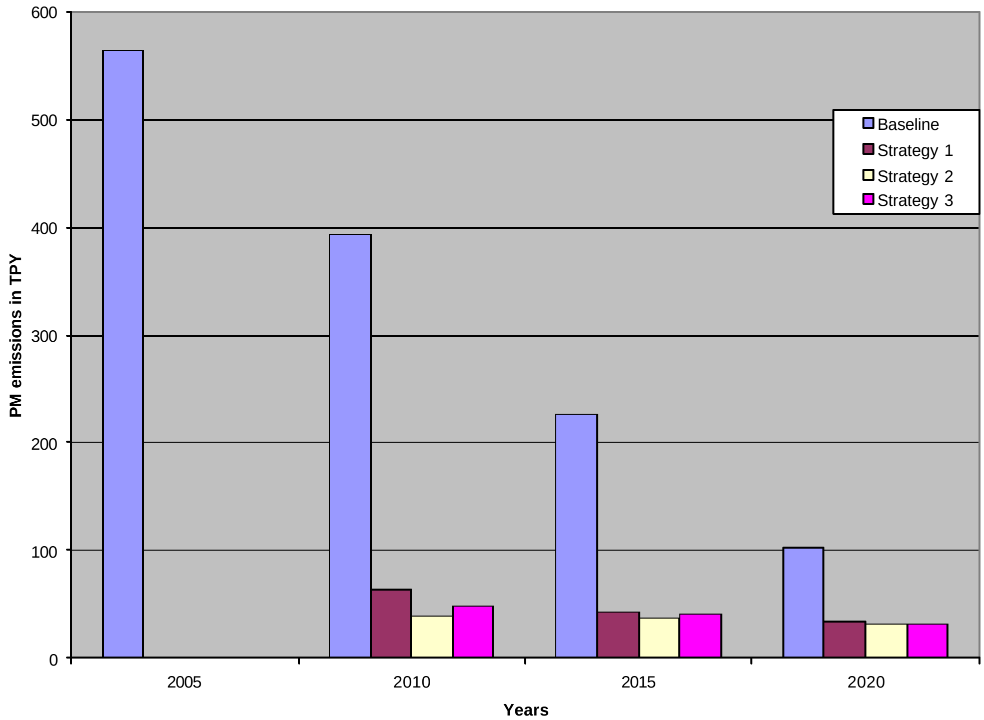
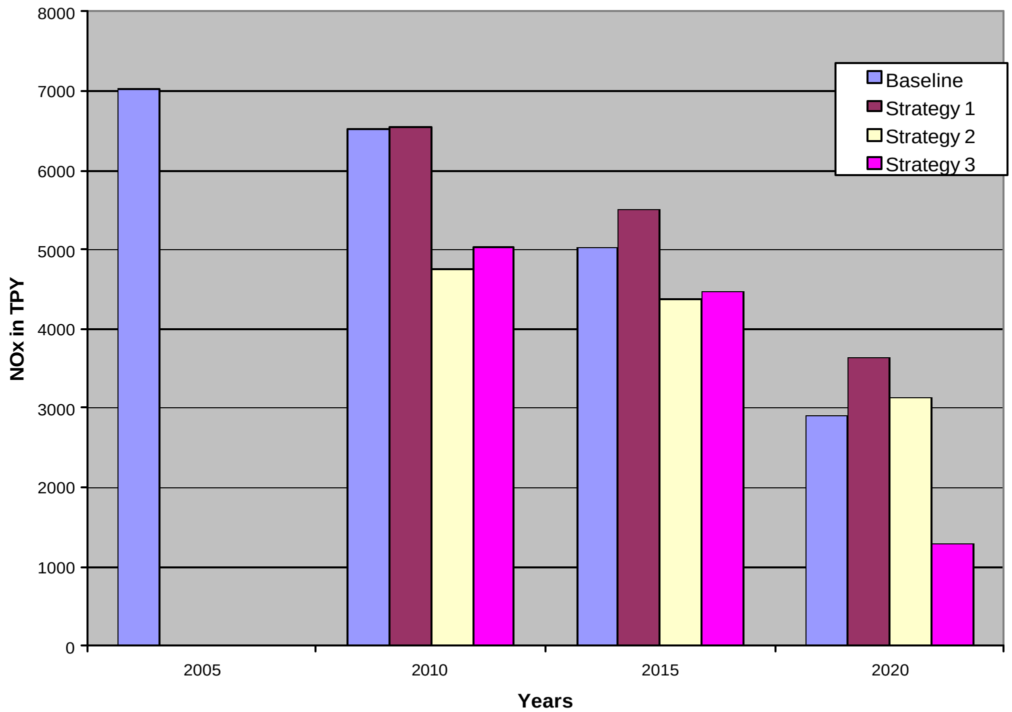


**Figure 3: Comparison of NOx Emissions for the Period 2005 – 2020**




## Conclusions

The port truck fleet modernization program has significant emission reduction benefits. However, any strategy to reduce emissions from port trucks must account for a variety of issues. Chief among these issues is the ability and willingness of the port truck owner to participate in the desired retrofit and modernization efforts. Profit margins for port truck drivers are slim and they lack the ability to raise rates in order to generate the money to pay for the costs associated with modernization. Any attempt to use regulatory mechanisms alone to induce truck owners into paying for modernization or retrofit of their trucks could well create a shortage of trucks willing to move goods at ports. Based on the results of this study, ARB staff concludes the following:

- The 12,000 port trucks operating at the 3 major California ports are a significant source of air pollution and operate in close proximity to communities.

- A fleet modernization strategy can be implemented that will substantially reduce emissions of diesel PM and oxides of nitrogen by 2010 with additional reductions by 2020.

- The most cost-effective strategy involves retrofitting the existing fleet with DPFs and NOx emission reduction strategies in combination with limited newer truck purchases. The strategy would also require new trucks entering port service to meet increasingly stringent emission standards, as well as additional emission reductions from the existing fleet when feasible.

- The recommended existing fleet modernization strategy is costly ($280 million) and likely cannot be paid entirely by the truck owners; thus, funding sources must be secured to help defer the cost of the replacement trucks and retrofit technologies.

- An enforceable mechanism is necessary to ensure that the modernized and retrofitted trucks stay in port service. This could be done by refunding the costs to the truck owners over time, perhaps in the form of a per-trip credit. Owners/operators would get points or credit each time containers were picked up or delivered to the port. A minimum number of trips would be required in order to receive the full incentive payment. Another option would be to establish contracts or binding agreements with the owners/operators. This option would also require a process for monitoring individual truck activity.

- A mechanism is also necessary to ensure that older, dirtier trucks do not enter port service as the fleet grows. This could be accomplished by requiring trucks that enter port service after 2006 meet increasingly stringent emission standards. These trucks would be equipped with DPFs and OEM engines that meet 2003[5], 2007, or 2010 standards.

- The recommended fleet modernization strategy would be accomplished in two phases. Phase 1 requires the retrofitting of the entire fleet (12,000 trucks) with highly effective DPFs. NOx reductions would be achieved by equipping the 10,500 pre-2003 trucks with a NOx reduction catalyst system. All pre-1994 vehicles would be retired (scrapped) and replaced with 1998-2002 MY vehicles. Phase 2 would require the entire port truck fleet to meet 2007 or 2010 engine standards by the year 2020.

- Program enforcement could be the responsibility of the ports through the terminal operators. Trucks would be monitored when they are processed at the terminals before container pick-up or delivery.

- The port truck fleet modernization program presents several challenges and will take intensive planning, coordination, and cooperation of all parties involved.

[5] 2.5 g/bhp-h certification standard for NOx+HC