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Driving on Fumes

Truck Drivers Face Elevated Health Risks from Diesel Pollution

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About CCSP

The Coalition for Clean & Safe Ports is a coalition of environmental, labor, faith, and community organizations promoting sustainable economic development at West Coast ports. We are working to clean up the port trucking industry, reduce environmentally harmful port emissions, and stimulate greater economic opportunities for surrounding port communities. To ensure a level playing field, the Coalition is organizing at the Ports of Oakland, Los Angeles, Long Beach, and Seattle, so that standards are lifted regionally and no one port is put at a competitive disadvantage.

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An appendix reviewing the literature on the topic of truck driver in-vehicle diesel exhaust exposure is available online at www.nrdc.org/policy.

Executive Summary

Diesel pollution is well known to be hazardous to human health. Groups at particular risk include workers in diesel industries, such as trucking and rail, and communities located near major sources of diesel pollution, such as ports and freeways. Truck drivers who serve ports are at especially high risk. They may be exposed to pollution from their own diesel trucks, and they drive in locations where there are many other sources of diesel pollution—including other port trucks, cargo-handling equipment, ships, and locomotives—and are likely to inhale soot from the air around them.

Our investigation is one of the first to measure truck drivers' exposure levels to diesel soot, or black carbon, inside trucks serving our nation's ports. To do so, we monitored the air inside the cabs of trucks—ranging in age from 1981 to 2006 model years—for an entire work shift serving the Port of Oakland. What we found was disturbing. All of the average black carbon levels measured within the truck cabs were at least 10 times higher than the background level of 0.3 $\mu g/m^3$ found in a residential area of Oakland; samples from inside the 1981 truck showed levels of black carbon roughly *25 times* higher than the background. These levels are significantly higher than what was previously found along truck corridors near the Port of Oakland and at Port of Oakland terminals, suggesting that diesel exhaust may be accumulating inside the truck cabs.

Thus port truck drivers face even greater health risks than do the residents of surrounding communities. The amount of black carbon we measured inside the truck cabs was high enough to increase health risks by up to 2,600 excess cancers per million drivers—double the level considered acceptable by the Occupational Safety and Health Administration (OSHA), and roughly 2,000 times greater than the level typically considered acceptable by state and federal environmental protection agencies. Although we were unable to quantify them, the non-cancer health risks, such as premature death, are likely to be even greater.

Our investigation indicated that the air in newer trucks tends to be slightly cleaner than the air in the oldest trucks, implying that some portion of the diesel particulate matter (DPM) that the drivers inhale comes from their own trucks. However, the DPM levels found inside the cabs of newer, cleaner trucks remained elevated across model years, showing greater variation depending on the location. This led us to conclude that most of the exposure was from surrounding diesel sources in the port environment.

Based on direct observations of three separate truck drivers' shifts, we also found that drivers spent a lot of time waiting in lines at the port, amounting to almost two-thirds of their day at or around the Port of Oakland. Levels of diesel soot at and around the port were second only to freeway levels among locations with the highest levels of diesel exhaust measured in this work.

To reduce health risks to drivers and local residents, it is necessary to clean up the port truck fleet, increase efficiency to reduce the time trucks spend at the terminals, and reduce pollution levels from other port sources.

CHAPTER 1

The Negative Health Effects of Diesel Pollution

Air quality–related health issues have been a major concern to those who work at our nation's ports and those who live nearby. Many of these health concerns are directly related to diesel exhaust from trucks, cargo equipment, ships, and trains, many of which are old and dirty and tend to be highly concentrated in areas near freeways, port terminals, and rail yards. Diesel engines emit a toxic brew of particulate matter (DPM), smog-forming nitrogen oxides (NOx), and volatile organic compounds.[1] Diesel exhaust can also contain an estimated total of 450 different chemicals, about 40 of which are listed by the California Environmental Protection Agency as toxic air contaminants with negative effects on health and the environment.[2]

Diesel Pollution Can Be Deadly

Diesel exhaust is a well-known human carcinogen,[3] estimated to be responsible for 70 percent of the total cancer risk from air pollution.[4] Notably, the occupational exposure of truck drivers, railroad workers, heavy-equipment operators, and other workers is associated with lung cancer risks 40 percent higher, on average, than in the population at large.[5] In fact, a recent study of the U.S. trucking industry found an excess risk of death due to lung cancer and ischemic heart disease particularly among drivers.[6] Numerous studies have documented a wide range of other adverse health impacts from long-term exposure to fine particulate matter, a major component of diesel exhaust. These include increased risk for cardiovascular disease such as atherosclerosis,[7] increased heart attacks,[8] increased emergency room visits for acute health events,[9] birth defects,[10] low birth weights,[11] premature births,[12] and increased rates of death.[13] A recent California Air Resources Board (CARB) report quantified some of the health impacts caused by diesel exhaust from freight transport in California; it found 2,400 premature deaths, 2,830 hospital admissions, 360,000 missed workdays, and 1,100,000 missed days of school in 2005.[14]

According to CARB, trucks are responsible for more than half of the estimated 2,400 premature deaths attributable to diesel exhaust from California freight transport in 2005.

Truck traffic near the Port of Oakland

BETH TRIMARCO

Health Risks Affect Workers and Communities

Diesel pollution is particularly severe in communities surrounding California's seaports. CARB reported that the cancer risk for residents of communities next to the Ports of Los Angeles and Long Beach was greater than 500 in a million, a risk 500 times higher than what the federal government considers acceptable.[15] Compared with the rest of the state, West Oakland residents are exposed to six times more diesel particulate matter per person.[16]

The negative health impacts of diesel pollution affect workers, too. Port workers ranging from longshoremen to truck drivers are exposed to high levels of diesel pollution on the job—and truck drivers are especially vulnerable. The vast majority of drivers work as independent contractors and must arrange for their own health insurance. But most are too poorly paid to afford it. In recent studies, 90 percent of drivers serving the Ports of Los Angeles and Long Beach reported having no health coverage, and in Oakland nearly two-thirds of drivers reported lacking coverage. Furthermore, as independent contractors, port drivers do not receive paid sick days, nor are they covered by workers' compensation insurance. Although all drivers and longshoremen are heavily impacted by the negative health impacts of diesel pollution, independent port drivers are especially susceptible when compared with employee workers. The fact that OSHA regulations protecting employee drivers while on the job do not also apply to and protect independent contractor drivers exacerbates the problem.

CHAPTER 2

Investigating Drivers' Exposure to Pollution Inside the Truck Cab

Our work investigates the exposure of port truck drivers to harmful pollutants in the course of their work and considers the potential health impacts from such exposure. Many studies on this issue have assessed health impacts based on air pollution modeling and estimates of pollution levels and have measured vehicle tailpipe emissions or roadway pollutant levels. We are aware of very few studies measuring the direct exposure to pollutants that drivers face inside the cabs of their trucks.[17]

Our goal was to gather information about the levels of diesel soot drivers are typically exposed to during their shift and whether the age of their trucks makes a significant difference in exposure. The small sample size of this work—only seven trucks—indicates the severity of the occupational health impacts but must be considered preliminary. We encourage air quality agencies to do a more comprehensive evaluation both of health impacts to drivers and of truck performance.

How We Obtained Our Air Samples

An air monitor was placed inside the cab of seven different trucks for one shift each in service at the Port of Oakland for a total of 68 hours of sampling time. The monitor, an Aethalometer, continuously recorded concentrations of black carbon, a pollutant associated with diesel exhaust.[18] The instrument was placed in the cab of each truck with a Global Positioning System (GPS) device attached to track each driver's route.[19] The Aethalometer was run for one day in a residential area of Oakland to obtain a background sample.[20]

A total of nine shifts were assessed, three of them accompanied by an observer. The observer documented specific activities, locations, and the time spent in each location. Details of these observations are summarized in the sidebar entitled *A Day With a Truck Driver*. Five drivers were employees of a private trucking company; the other two were independent owner-operators. One truck was monitored in triplicate to determine the degree of variation possible from day to day. The trucks' model years were: 1981, 1986, 1994, 1999 (two trucks), 2001 (alternative-fuel), and 2006. Details of the trucks monitored are listed in Table 1.

Black carbon measurements were processed by taking averages of the minute-by-minute measurements over the course of the whole shift, or, where an observer was present, over the aggregated time spent in each of four types of locations. Average exposures to black carbon were converted to DPM to assess occupational cancer risk according to accepted guidelines.[21]

Table 1: Truck and Driver Information					
Date of Monitoring	**Years Driving**	**Model Year**	**Mileage**	**Windows**	**Reported Health Problems**
7/2/07*	4	1999	572,592	Open	Back pain
7/18/07,* 7/19/07, 8/16/07	15	1994	N/A	Open	None
7/20/07*	3	1999	717,622	Closed	Asthma
7/24/07	21	1986	N/A	Open	Eye problems
7/25/07, 8/3/07**	15–18	1981	313,510	Varied	None
8/13/07	11	2001***	253,439	Closed	Breathing problems****
9/4/07	2	2006	217,567	Closed	Back pain

* Monitoring runs accompanied by an observer.

** Monitoring on 7/25 stopped after several hours, likely due to accidental disconnection of power source; monitoring was resumed on 8/3.

*** Truck used liquefied natural gas (LNG). All other trucks in this work were powered by diesel fuel.

****This driver mentioned that when he gets back from vacation and begins working again, he gets nasal congestion when sleeping.

Despite numerous requests for information, we were unable to ascertain the mileage of two test vehicles.

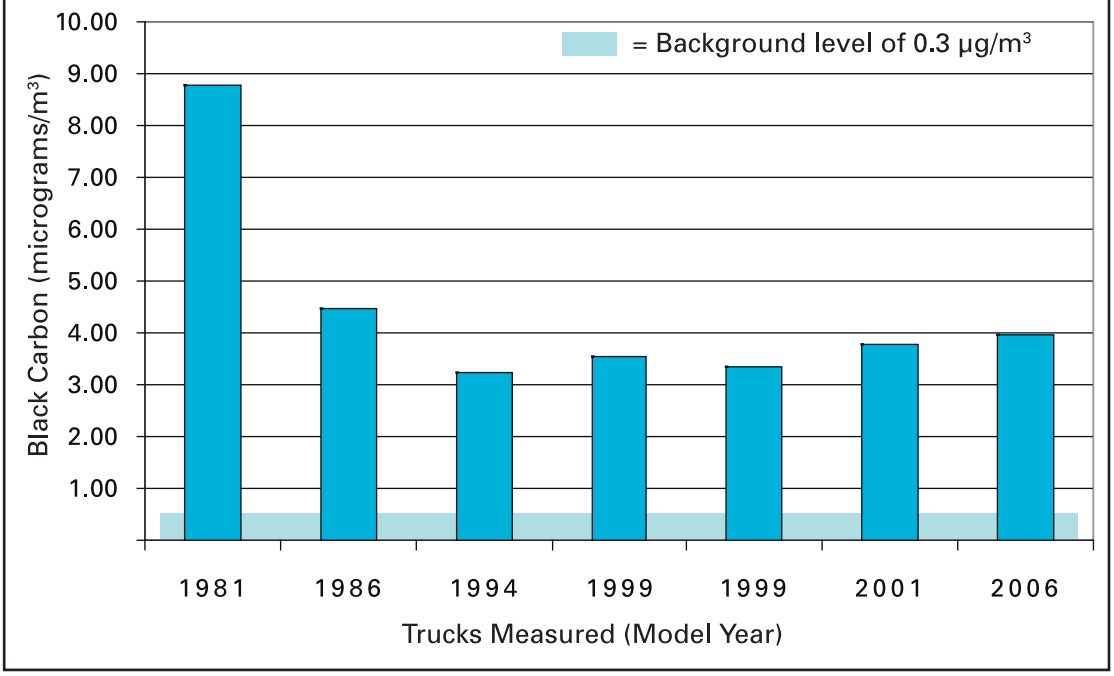
Investigation Reveals Elevated Pollution Levels Inside the Truck Cab

The average black carbon concentrations measured during a typical work shift for each truck is shown in Figure 1. The concentrations are similar for all except the oldest truck, which was visibly smoking. The level of black carbon was more than twice as high in the cab of this truck as in all of the newer trucks, suggesting that some of the smoke from the engine was getting inside the cab, even though the truck was moving most of the time.

The two 1999 model year trucks had nearly identical average black carbon levels in the cabs (3.4 and 3.5 micrograms per cubic meter (μg/m^3)). Although the measurements were taken several weeks apart, we believe the very close averages are a coincidence and cannot be taken to represent the average concentration in all 1999 trucks. In fact, three daily measurements were made on the same 1994 truck over the span of one month, and the results (2.9, 3.0 and 4.8 μg/m^3) had a range broad enough to suggest the heavy influence of differing background conditions.

All of the average black carbon levels measured within the truck cabs were at least 10 times higher than the background levels of 0.3 μg/m^3 in a residential area of Oakland; the 1981 truck that was sampled showed levels of black carbon more than 25 times higher than the background.

Figure 1: Average black carbon levels measured inside trucks



The three monitoring runs done with an observer yielded information about how different locations impact drivers' exposure to soot. Each of the three shifts was divided into four location categories: "Port," "Road," "Freeway," and "Yard." "Port" included terminals, waiting areas outside of terminals, and any roads near terminals. "Road" included any thoroughfares that were not adjacent to the port complex and not considered a freeway. They also included customer drop-off sites, which were in Pittsburg, Hayward, and San Francisco, California. "Freeway" refers to a high capacity, high speed highway with access via ramps and with 100 percent grade separations. "Yard" refers to the lot at which these trucks are based.

A Day With a Truck Driver

My name is Mohammed Asif, and I have been driving at the Port of Oakland for five years. The port truck drivers get no respect inside the port. I usually work 10 hours a day moving containers from one terminal to another. In order to make a decent living I try to make four trips a day. But usually I can only make three, because many times I have to wait up to two hours to pick up a container at the terminal.

While we wait in these lines our trucks are polluting the air and getting ourselves and the community sick from this pollution. I know that my truck pollutes the air, but there is nothing that I can do about it because as an independent port truck driver I cannot afford a new one.

I don't have health insurance. Fortunately, my wife has insurance for herself and our child. I am lucky that I don't currently have any medical problems, but many of my fellow drivers have breathing problems and back pain. I want to work hard, provide a good life for my family, and not pollute the air that we all breathe. But the trucking system at the port is so broken that it isn't possible.

Figure 2: Time spent in different locations for an average shift of three truck drivers

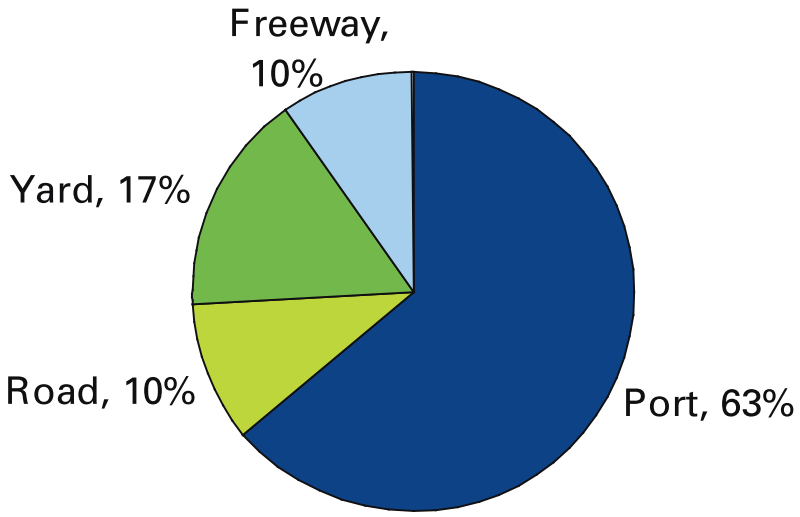


Figure 3: Average concentration of diesel particulate matter for four location types, measured in the cabs of three truck drivers during the course of a shift.

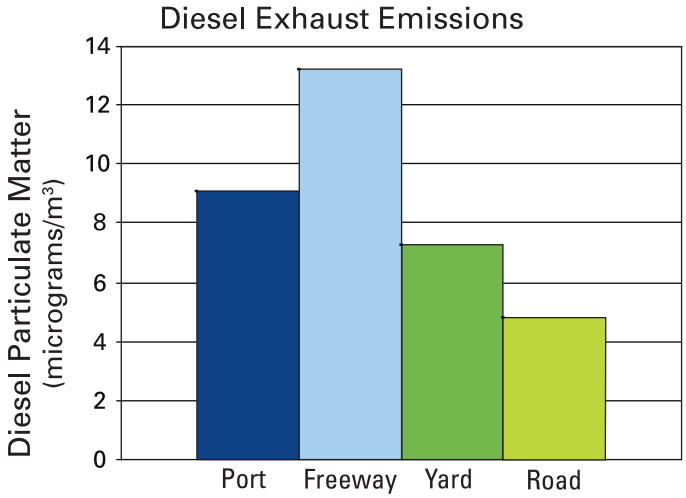


Figure 2 shows where the three drivers spent their time during a typical workday. The most time, almost two-thirds of a shift, was spent at or near the Port of Oakland. The remaining time was divided among the yard (17 percent), freeways (10 percent), and roads (10 percent). Estimated levels of DPM based upon black carbon measured[22] in the truck cabs varied considerably depending on location. An average DPM level was calculated for each location type, averaged over the three days, and weighted by the time spent there. The highest average DPM was attributable to freeway driving (13.2 µg/m^3), followed by the port area (9.1 µg/m^3), the yard (7.3 µg/m^3), and roads (4.8 µg/m^3) (see Figure 3).

A range of elevated cancer risks was calculated, based on the highest and lowest average black carbon concentrations that drivers were exposed to inside their truck cabs over the course of a typical shift. We assumed a 40-hour workweek for 50 weeks a year for 40 years. Elevated cancer risks for truck drivers ranged from 966 to 2,631 cases in a million, which is more than double the level considered acceptable by the Occupational Safety and Health Administration (OSHA) and up to 2,000 times greater than typically considered acceptable by environmental protection agencies.[23]

Waiting at the Port: A Day With a Truck Driver, Part II

Maria Minjares, coauthor of this report, spent three full shifts riding along with truck drivers serving the Port of Oakland in July 2007. She observed that an average transaction at the port takes almost two hours to complete; the majority of time is spent waiting in a series of lines to receive instructions from port employees. Waiting time on the lines is typically between 5 and 30 minutes—during which trucks are often left idling—and these times can be compounded by breaks taken by port employees. Additionally, on several occasions during the course of Minjares's observations, drivers received incorrect or incomplete instructions from the port and were forced to return to a line to wait for correct instructions. In one case, a driver spent nearly four and a half hours at the Port of Oakland to complete a single assignment.

Almost two-thirds of the truck drivers' exposure to diesel particulate matter (DPM) recorded in this work took place at the port, despite the fact that background DPM levels at the port are significantly lower than those on freeways. The protracted length of time needed to complete each trip to the port, and the resultant long exposure times to DPM emissions, are in large part responsible for this finding.

Drivers did not have any designated breaks to eat or to use a rest room, and some pressed through their shift without a single break. Access to rest rooms was limited: Although portable toilets were dispersed along the roads near the port, they were not utilized by any of the drivers, who apparently consider them a last resort. Additionally, some drivers reported health problems related to their work. One driver with asthma said, "At the end of my shift, when I get home, I wash my face. It takes a few cotton swabs, and they are covered in black when I am done."

Comparing Levels of Background Pollution

Heavy-duty trucks are the largest source of diesel particulate matter in California,[24] affecting the health of residents living near truck routes and especially the health of drivers. The background health risk from DPM in urban areas is 500 to 800 potential cancers per million people.[25] This risk roughly doubles in areas with major diesel sources such as ports and rail yards and along major transportation corridors.[26] Truck drivers likely face health risks that are even higher than the risks faced by residents living near these facilities, especially if they live as well as work in impacted areas.

The average DPM levels in the truck cabs of this investigation (8.6 to 23.4 $\mu g/m^3$) are significantly higher than levels found previously along truck corridors near the Port of Oakland and at Port of Oakland terminals, suggesting that diesel exhaust is accumulating inside the truck cabs. In Table 2, DPM levels and corresponding cancer risks found in this work are compared with those for California at large and for those documented at freight transport facilities and on school buses. DPM levels in the seven trucks tested were similar to the levels found in school buses that we tested in 2000.[27] Similar levels were also documented in a previous study on a Port of Oakland terminal.

Table 2: Diesel Particulate Matter Levels Inside the Cab of Trucks Compared to Other Locations [28]

	Inside Truck Cabs	7th Street Oakland Truck Corridors[29]	Port of Oakland Terminal[30]	Inside School Buses[31]	Oakland Background[32]
Diesel Particulate Matter (µg/m³)	9–23	6	13	8–19	1
Associated Cancer Risk Levels	1,000–2,600 per million (occupational)	2,300 per million	1,500 per million (occupational)	23–46 per million (limited duration)*	400 per million

*Duration based on 1 to 2 hours on a school bus per day for 180 days per year for 10 years.

These higher in-vehicle DPM levels are not surprising given recent studies indicating that exhaust pollutants are concentrating inside passenger vehicles at unsafe levels. One study of nonsmoking Los Angeles residents estimated that up to half of their total DPM exposures occur during their 90 minute-per-day average drive time.[33] Ultrafine particles can concentrate even more inside vehicles.[34] In fact, several studies have found that high concentrations of black carbon and other pollutants such as ultrafine particles, nitric oxide, and particle-bound polycyclic aromatic hydrocarbons (PAHs) are primarily driven by the amount of diesel truck traffic.[35]

The significantly higher black carbon measurements documented on freeways compared with other roadways is similar to the findings of other studies. For example, preliminary results from the Harbor Communities Monitoring Study show black carbon levels on freeways to be roughly double the level found on surface or residential streets.[36] That study also showed much higher black carbon levels in the morning than in the afternoon—something we did not find in this work. Meteorological conditions such as wind speed may account for the difference between morning and afternoon results in the Harbor Communities study.

Differing weather patterns and several other factors lead to substantial day-to-day variability. For example, the trucks measured in this work traveled in similar areas around the Port of Oakland, but they did not have identical routes. Surrounding emissions sources such as trucks, trains, ships, and stationary sources likely varied somewhat in activity and pollutant outputs during each test day. Due to its small sample size, our investigation had limited ability to capture the full range of variability likely to occur. Furthermore, the characteristics of the Aethalometer and the general conversion factor for black carbon to DPM contributed to some uncertainty.[37]

Finally, it should be noted that the extent to which emissions from a truck penetrate the inside of the truck cab is unknown. A 1978 study found significant contributions to driver exposure from their own trucks, but those trucks were old and poorly maintained.[38] The study found that in-cab pollutant levels doubled in trucks that had leaks (such as holes in the floor around the pedals); this may have been the case with the 1981 truck in our work, which tested at more than twice the concentrations found in the other trucks. A more recent study suggests that seepage of diesel exhaust into a truck cab worsens with age due to leaks from the cab's rubber seals that allow exhaust from the engine compartment to enter the cab.[39]

CHAPTER 3

Cleaning Up the Fleet

A number of programs have been developed to address the impacts of diesel exhaust from heavy-duty trucks in California, including idling limits and exhaust control retrofits. Several incentive funding programs exist in California to help offset the costs of cleaning up diesel trucks. The Carl Moyer Program provides funding for retrofits and for the purchase of alternative fuels or newer, cleaner heavy-duty trucks, within strict eligibility guidelines.[40] A program specific to Southern California, Gateway Cities, was established to remove pre-1984 heavy-duty trucks from the roads and has so far replaced more than 600 of them with 1994 or newer trucks.[41] In Northern California, the Sacramento Emergency Clean Air and Transportation (SECAT) program offers funding for retrofits and newer, cleaner engines and vehicles and has replaced more than 700 old trucks so far.[42] Last, the Port of Oakland Truck Replacement Project will fund upgrades to 1999 or newer model years for 80 trucks serving the Port.[43]

Idle Rules

Several years ago, CARB passed a five-minute idling limit for trucks and banned all idling within 100 feet of residential areas. CARB later required the use of auxiliary power units or alternative sources of power for the sleeper cabs of trucks when drivers were using them to rest or sleep. The rules exempt certain situations, such as waiting in line at the gates of port terminals, rail yards, or distribution centers. Assembly Bill 2650, passed in 2003, attempted to address the excessive idling occurring at ports by requiring port terminals to operate in a manner that prevents trucks from idling outside of the terminal for more than 30 minutes. If a terminal violates the rule, it is fined $250, and monetary returns are used for the California Ports Community Air Quality Program Fund.[49] According to the Bay Area Air Quality Management District (BAAQMD), which is responsible for the enforcement of AB 2650 at the Port of Oakland, only five violations have been filed, of which three have been settled (in 2004), yielding a total of just $750.[50] Apparently no further funding has been generated, and enforcement efforts have decreased since the law's implementation.[51] Based on our limited observations of three drivers' shifts, it appears that idling at the Port of Oakland is still a significant problem.

The Strategic Growth Plan for California includes a Goods Movement Action Plan that calls for sweeping programs to clean up the truck fleet serving major ports and rail yards.[44] The Highway Safety, Traffic Reduction, Air Quality and Port Security Bond Act of 2006 (Proposition 1B) is expected to fund several thousand truck replacements, among many other items related to the movement of goods.[45] It should be noted that the bond funding, while a helpful step toward mitigating pollution from freight transport, will provide only $1 billion of the $10 billion that CARB determined would be necessary for this purpose.[46] The port programs outlined in the sidebar *A New Approach to Socially Responsible Trucking*, together with the regulatory measures discussed below, may help close this gap.

Two separate regulations are under development by CARB. The "Port Truck" regulation will mandate the cleanup of trucks that serve major ports and rail yards in the state. Approximately 18,000 heavy-duty trucks will need to be retrofitted, replaced or otherwise upgraded by 2009.[47] A second proposal covers all heavy-duty trucks, requiring further clean up in 2014 and beyond.[48] Both of these rules can be considered backup to the port-proposed cleanup program, intended to offer assurances that the fleets will be cleaned up. However, neither proposal offers funding.

A New Approach to Socially Responsible Trucking

The Clean Trucks Program, proposed by the Ports of Los Angeles and Long Beach would replace or retrofit 16,000 harbor trucks in five years, limit terminal access with tariffs, and allow only "clean" trucks into terminals. The Clean Trucks Program seeks to create concession agreements between the ports and trucking companies through which the ports can set uniform environmental standards. The ports would require trucks serving their terminals to meet 2007 emission standards, with a progressive ban on old trucks phasing in between 2008 and 2012.[52] Trucks not meeting the standards would be subject to a Truck Impact Fee. The Port of Oakland is contemplating proposing a similar program.[53]

The Coalition for Clean & Safe Ports is a coalition of environmental, community, and labor organizations working to promote sustainable trade through California's largest ports. The Coalition supports the ports' efforts to implement a concession model for port trucking. The concession model will allow the ports to set environmental, community, and labor standards for trucking companies operating at the ports. Setting uniform standards that all companies must follow will promote investment in clean trucks, result in a sustainable reduction of pollution, and increase the efficiency of port operations. Requiring employee drivers through the concession model will shift the responsibility of maintaining new trucks to the trucking companies and will afford drivers the protection of health and safety laws. Independent contractor drivers do not currently have OSHA protections on the job, whereas employee drivers do.

CHAPTER 4

Conclusions and Recommendations

The most striking finding of this work is that all of the truck drivers that participated are exposed to unhealthy levels of soot, regardless of how new or clean their truck is. This finding suggests that in order to reduce drivers' health risk, it is likely necessary to upgrade the port truck fleet to "clean" trucks, reduce wait times at the terminals, and reduce pollution levels from other port sources. While this work focused on trucks serving the Port of Oakland, we expect similarly severe conditions affecting truck drivers serving the Ports of Los Angeles and Long Beach. Further study is clearly called for to assess the finer details of exposure based on location and individual truck characteristics.

The major health impacts occurring within the port trucking industry highlighted here should be taken as a call for immediate action to mitigate port pollution. Not only does the port truck fleet need to be cleaned up as quickly as possible, but it is clear that improvements are needed on a fleetwide, statewide basis in order to reduce the levels of diesel soot to which truck drivers are exposed. All major sources of freight transport pollution—ships, locomotives, cargo equipment, and trucks—should be addressed simultaneously.

The following recommendations provide a roadmap for reducing diesel pollution and minimizing the health threats to truck drivers working at and near California's ports.

PORTS AND RAIL YARDS

- The Ports of Los Angeles, Long Beach, and Oakland should use their authorities as landlords to implement concession agreements (contracts that set environmental, community, and labor standards) for all port trucking companies in order to achieve a quick and sustainable clean up of the port truck fleet. In addition to requiring clean trucks, it is important that these concession agreements require the use of employee truck drivers in order to shift the maintenance responsibilities to the trucking companies.
- Ports should ensure that all existing air quality planning goals are met on time and should impose green standards on all tenants.
- Ports should detail enough full-time staff members to properly enforce regulations, including idling restrictions, both on port property and at the gates.
- Rail yards should commit to phasing out all locomotives that cannot achieve 90 percent reductions in particulate matter from current standards (U.S. EPA Tier 2). They should also begin to electrify infrastructure; institute clean truck programs; ensure that all vehicle, equipment, and locomotive replacements are the cleanest, most efficient models available; and utilize operational efficiency measures to reduce pollution.

REGULATORS

- EPA should expedite implementation of new emission standards for locomotives and marine vessels.
- The California Air Resources Board should move forward quickly with its Goods Movement Emission Reduction Plan, including rules requiring clean trucks, shoreside power, and cleaner marine fuels, among other measures.

POLICYMAKERS

- Governor Schwarzenegger should work with the California legislature to implement container fees for major ports in California in order to help fund the replacement of polluting equipment.
- Policymakers should ensure that a portion of Proposition 1B infrastructure bond funding goes to alternative forms of freight transportation that reduce pollution and fossil fuel use, such as electrified rail projects.

DRIVERS, OWNERS, AND FLEET MANAGERS

- Regular maintenance to keep trucks in good working condition should be performed.
- Vehicles should be checked daily to make sure they are not smoking or burning excessive amounts of fuel or oil. Upon recognition of any of these problems, the vehicle should immediately be taken out of service for maintenance.
- Idling limits set by the state should be followed and idling should be minimized in order to save fuel, reduce pollution, and limit exposure to unhealthy exhaust.
- Funding available to help offset the cost of purchasing cleaner replacement trucks or exhaust controls for older trucks should be aggressively pursued.

Afterword

By Margaret Gordon, Co-Director, West Oakland Environmental Indicator Project and Wafaa Aborashed, Executive Director, Healthy San Leandro Environmental Collaborative

For most people, the word "neighborhood" conjures up images of quiet tree-lined streets, children riding their bicycles under clear skies, and perhaps the occasional ice cream truck driving down the street. But, that's not the reality in our neighborhoods. Instead our neighborhoods are inundated with hundreds of diesel semi-trucks each day, carrying containers to and from the Port of Oakland, the airport and distribution centers. Maybe it's no surprise that we have so many residents with asthma and other breathing problems. These trucks clog our streets and the air surrounding our homes and schools. The black diesel plumes emerging from the trucks' tailpipes pose serious health threats, like cancer, asthma, and other respiratory problems, to the residents living in West Oakland, East Oakland and San Leandro neighborhoods.

The Port of Oakland, already one of the nation's largest container ports, is only getting busier. With plans for expansion in the works, the communities bordering the Port can only expect more truck traffic, noise pollution, and toxic soot enveloping their neighborhoods. In fact, the Port estimates truck traffic to increase to 22,000 trips per day by 2010. But those trucks don't move themselves. It's not often that we think of the people who sit in driver's seat of each of those of trucks, but we should.

Port truck drivers, like those of us living in nearby Port communities, are exposed to high levels of toxic diesel pollution in their everyday lives. Not only are truck drivers breathing in exhaust from their own polluting trucks, but they are also exposed to a whole host of other sources of diesel pollution, including cargo equipment and ships carrying freight. Instead of viewing the trucks as our "enemies," we recognize that there are humans inside each of those trucks—each with their own personal story and their own health issues. Some of the drivers are suffering from asthma or other illnesses; others are working extra-long hours to support their families. Similar to the residents in our communities, port truck drivers are an at-risk population that shouldn't be overlooked. As two groups within our society who share the unfair burden of high exposure to diesel pollution, we are working in unity to get pollution from trucks and port operations cleaned up in order to protect our health and improve our quality of life.

Endnotes

1 California Air Resources Board, "Draft Diesel Exposure Assessment," A-7 (1998).

2 Mauderly JL. "Diesel Exhaust," *Environmental Toxicants: Human Exposures and Their Health Effects*, ed. M Lippman (New York: Van Nostrand Reinhold, 1992).

3 Dawson, et al. "Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant, Part B: Health Risk Assessment for Diesel Exhaust," *Public and Scientific Review Panel Review Draft*, February 1998.

4 California Air Resources Board, *Diesel Risk Reduction Plan*, October 2000.

5 Office of Environmental Health Hazard Assessment, Part B: Health Risk Assessment for Diesel Exhaust, 1998.

6 Laden F, Hart J, Smith T, Davis M, Garshick E. "Cause-Specific Mortality in the Unionized U.S. Trucking Industry," *Environ Health Perspect*, 2007 Aug:115(8):1192-6.

7 Kuenzli N, Jerrett M, Mack WJ, Beckerman B, LaBree L, Gilliland F, Thomas D, Hodis HN. "Ambient Air Pollution and Atherosclerosis in Los Angeles," *Environ Health Perspect*, 2005 Feb:113(2):201-6. Miller KA, Siscovick DS, Sheppard L, Shepherd K, Sullivan JH, Anderson GL, Kaufman JD. "Long-term Exposure to Air Pollution and Incidence of Cardiovascular Events in Women." *N Engl J Med*, 2007 Feb 1:356(5):447-58. Hoffman B, Moebus S, Mohlenkamp S, Stang A, Lehman N, Dragano D, Schmermund A, Memmesheimer M, Mann K, Erbel R, Jockel K-H. "Residential Exposure to Traffic Is Associated With Coronary Atherosclerosis." *Circulation*, published online July 16, 2007, DOI: 10.1161 / CIRCULATIONAHA.107693622.

8 Pope CA, Muhlestein JB, May HT, Renlund DG, Anderson JL, Horne BD. "Ischemic Heart Disease Events Triggered by Short-term Exposure to Fine Particulate Air Pollution." *Circulation* 2006 Dec 5;114(23):2443-8.

9 Schwartz J, Slater D, Larson TV, Person WE, Koenig JQ. "Particulate Air Pollution and Hospital Emergency Room Visits for Asthma in Seattle." *Am Rev Respir Dis*, 1993 Apr; 147(4):826-31.

10 Ritz B, Wilhelm M, Zhao Y. "Air Pollution and Infant Death in Southern California, 1989–2000." *Pediatrics*, 2000 Aug:118(2):493-502.

11 Wilhelm M, Ritz B. "Residential Proximity to Traffic and Adverse Birth Outcomes in Los Angeles County, California, 1994–1996." *Environ Health Perspect*, 2003 Feb; 111(2):207-16.

12 Wilhelm M, Ritz B. "Local Variations in CO and Particulate Air Pollution and Adverse Birth outcomes in Los Angeles County, California, USA." *Environ Health Perspect*, 2005 Sep:113(9):1212-21.

13 Jerrett M, Burnett RT, Ma R, Pope CA, Krewski D, Newbold KB, Thurston G, Shi Y, Finkelstein N, Calle EE, Thun MJ. "Spatial Analysis of Air Pollution and Mortality in Los Angeles." *Epidemiology*, 2005 Nov:16(6):727-36.

14 California Air Resources Board. "Quantification of the Health Impacts and Economic Valuation of Air Pollution From Ports and Goods Movement in California." Appendix A in Emission Reduction Plan for Ports and Goods Movement (GMERP), March 22, 2006:14. www.arb.ca.gov/planning/gmerp/march21plan/appendix_a.pdf.

15 *Ibid.* Note that this study only considered "on-port" sources excluding pollution from trucks and locomotives operating in service to the ports. Therefore the risk estimates are likely significantly understated.

16 Pacific Institute. "West Oakland Diesel Particulate Matter Emissions Inventory and Air Quality Monitoring Study." November 14, 2003: 22. www.pacinst.org/diesel.

17 One 1978 study of exhaust systems contaminating driver compartments of older, poorly maintained diesel trucks. Ziskind R, Carlin T, Ballas J. "Evaluation of Gas Hazards Inside Heavy-Duty Diesel Truck Cabs." Proceedings of the American Chemical Society, 4th Joint Conference on Sensing of Environmental Pollutants, pp. 377–383. Washington, D.C.: American Chemical Society, 1978. A November 2007 study is the first that we are aware of since the Ziskind study to look at driver exposure again: Davis ME, et al. "Driver Exposure to Combustion Particles in the U.S. Trucking Industry." *Journal of Occupational and Environmental Hygiene*, 4:848-854, November 2007.

18 Curtiss H, MPH, Practicum Project: "Diesel Traffic and Black Carbon Measurements in the Seattle Metropolitan Area." University of Washington, Department of Environmental and Occupational Health Sciences, May 19, 2005, http://depts.washington.edu/envhlth/news/abstract05/abstracts_curtiss.html, http://www.osti.gov/energycitations/servlets/purl/825311-jMlxTj/825311.PDF, www.nescaum.org/documents/allen-spatial-bc.pdf. An Aethalometer employs optical analysis to determine the concentration of black carbon particles collected from an air stream passing through a filter.

19 A plastic sampling tube was taped near the driver at breathing level, sucking air in at a rate of about 4 liters per minute.

20 It should be noted that there is no "typical" day. However, previous measurements in the same location have been very similar; all have averaged less than 0.5 $\mu g/m^3$ of black carbon. The "urban background" location we used is several miles from downtown Oakland in the China Hill neighborhood, approximately 1,200 feet south of the I-580 freeway; heavy-duty trucks are barred from that segment of the freeway.

21 A rigorous review of the correlation between black carbon measurements and DPM concentrations yields the following: The ratio of black carbon to DPM is 0.375 ± 52%, resulting in a conversion factor for BC to DPM of 1.8 to 5.6. We utilized the average. Therefore, DPM = 2.67 * BC. See: Fruin SA, et al. "Black Carbon Concentrations in California Vehicles and Estimation of In-Vehicle Diesel Exhaust Particulate Matter Exposures." *Atmospheric Environment* 38 (2004) 4123–4133. Cancer risks associated with DPM were calculated per the following methodology from California EPA, Office of Environmental Health Hazard Assessment, Air Toxics Hot Spots Program Risk Assessment Guidelines, August 2003, www.oehha.ca.gov/air/hot_spots/pdf/HRAguidefinal.pdf.

$$\text{Dose Inhaled} = \frac{(\text{Cair})(\text{DBR})(\text{A})(\text{EF})(\text{ED})(1\text{x}10^{-6})}{\text{AT}}$$

Parameter	Definition	Value
Dose Inhaled	Dose through inhalation (mg/kg/day)	
Cair	Concentration in air (µg/m3)	2.67*BC
DBR	Daily breathing rate (L/kg body weight-day or L/kg-day)	149 (Recommended value for outdoor workers for an 8-hour day)
A	Inhalation absorption factor	1 (currently used for all substances included in CARB's Hot Spots program)
EF	Exposure frequency (day/year)	250 days/year
ED	Exposure duration (years)	40 years
AT	Averaging time period over which exposure is averaged, in days	14,600 days (40 years)
1 x 10-6	Micrograms to milligrams conversion (10^{-3} mg³µg), liters to cubic meters conversion (10^{-3} m³/l)	

Cancer Risk Potency Factor for diesel PM = 3.0 x 10^{-4} per µg/m³ or 1.1 per mg/kg-day
Cancer Risk (chances per million) = Dose Inhaled (mg/kg-day) x Cancer Potency (mg/kg-day)$^{-1}$ (1x10^{6})

22 Again, note that Black Carbon measurements were converted to Diesel PM using the following formula: DPM = 2.67 * BC (Fruin et. al, 2004).

23 Regulators generally presume that a cancer risk of 1 in 1 million from lifelong exposure to a hazardous chemical is an "acceptable risk," according to OEHHA guidance at www.oehha.ca.gov/pdf/HRSguide2001.pdf.

24 Based on all diesel sources listed by 2006 California Air Resources Board Estimated Emissions, Statewide, www.arb.ca.gov/app/emsinv/emssumcat_query.php?F_YR=2006&F_DIV=-4&F_SEASON=A&SP=2007&F_AREA=CA#7.

25 CARB, 2006, p. A-57.

26 *Ibid.*

27 NRDC. "No Breathing in the Aisles," February 2001, www.nrdc.org/air/transportation/schoolbus/sbusinx.asp.

28 It should be noted that the black carbon and elemental carbon levels reported in studies and used to calculate DPM levels in this table are based on varying measurement techniques. The numbers reported in this table should serve as approximate estimates.

29 Based on limited monitoring done by NRDC near the 7th Street truck route in West Oakland, showing average black carbon levels of 2.1 µg/m3 (diesel PM = 5.8 µg/m3).

30 Based on NIOSH Health Hazard Evaluation Report (HETA #2003-0246): Joint Pacific Marine Safety Code Committee, Port of Oakland, California, American Presidents Line Facility, Oakland, California, January 2005. This study showed average concentrations of 5.0 µg/m3 elemental carbon at the terminal.

31 NRDC, 2001.

32 Based on background sample taken in Oakland China Hill neighborhood.

33 Rodes C, Sheldon L, Whitaker D, Clayton A, Fitzgerald K, Flanagan J, DiGenova F, Hering S, Frazier C. "Measuring Concentrations of Selected Air Pollutants Inside California Vehicles." Final Report, Contract No. 95-339. California Air Resources Board, Sacramento, California, 1998. Fruin SA, Winer AM, Rodes CE. "Black Carbon Concentrations in California Vehicles and Estimation of In-vehicle Diesel Exhaust Particulate Matter Exposure." *Atmos. Environ.*, 34: 4123-4133, 2004.

34 Fruin S. "The Importance of In-Vehicle Exposures." California Air Resources Board meeting presentation, Sacramento, California, December 9, 2004, ftp.arb.ca.gov/carbis/research/seminars/fruin/fruin.pdf.

35 Fruin S, Westerdahl D, Sax T, Fine P, Sioutas C. "Predictors of In-Vehicle Ultrafine Particulate Matter Concentrations and Other Vehicle-Related Pollutants on Los Angeles Roadways." Presented at the American Association for Aerosol Research, Annual Conference, Austin, Texas, October 20, 2005. Westerdahl D, Fruin S, Sax T, Fine P, Sioutas C. "A Mobile Platform Approach to Measuring Ultrafine Particles and Associated Pollutant Concentrations on Freeways and Residential Streets in Los Angeles." *Atmospheric Environment* 39:3597-3610.

36 Harbor Communities Monitoring Study presentation to CARB, January 25, 2007, www.arb.ca.gov/research/mobile/hcm/hcm-pres.htm

37 Many of these issues have been summed up in the following paper. For example, the portion of black carbon attributable to diesel exhaust varies due to contributions to black carbon from other sources such as coal combustion, fires, and char-grilling. See Borak J. et al. "Comparison of

NIOSH 5040 Method Versus Aethalometer to Monitor Diesel Particulate in School Buses and at Work Sites." *AIHA Journal*, March/April 2003; 64, 2; ABI/INFORM Global p. 260.

38 Ziskind et al., 1978.

39 Smith et. al., 2007.

40 Carl Moyer Program Guidelines: Part II of IV. November 17, 2005. This program recently incorporated "Fleet Modernization" guidelines to subsidize the cost of purchasing newer (used) truck models to replace the oldest, most polluting trucks.

41 Gateway Cities: Clean Air Program. "Program Overview," www.gatewaycog.org/cleanairprogram/overview/overview.html. Personal communication, Gateway Cities, September 13, 2007, and www.earthtimes.org/articles/show/news_press_release,163728.shtml.

42 Sacramento Emergency Clean Air and Transportation. "What Is SECAT?" www.4secat.com. Personal communication, Kristian Damkier, PE, Assoc. Air Quality Engineer, Sacramento Metropolitan Air Quality Management District, September 13, 2007.

43 Port of Oakland. "Programs: Port of Oakland Truck Replacement Project," www.portofoakland.com/environm/prog_06.asp.

44 California Environmental Protection Agency. "Goods Movement Action Plan." January 2007:II-3.

45 Legislative's Analysts Office. "Proposition 1B," www.lao.ca.gov/ballot/2006/1B_11_2006.htm. These bond funds, totaling $1 billion for air quality mitigation projects, will be distributed by CARB.

46 CARB, GMERP, 2006, p. 130.

47 According to the Updated Draft Drayage Truck regulatory proposal language, September 26, 2007, www.arb.ca.gov/msprog/onroad/porttruck/porttruck.htm.

48 http://www.arb.ca.gov/msprog/onrdiesel/onrdiesel.htm.

49 Southern California Association and Governments. "Assembly Bill 2650 (Lowenthal), Air Pollution: Truck Emissions and Marine Terminals." August 2002. www.scag.ca.gov/committees/pdf/rc/rc080302agn.pdf.

50 Guy B, Gambardella T. Bay Area Air Quality Management District. Telephone communication, August 16, 2007.

51 Bay Area Air Quality Management District. "BAAQMD AB 2650 Idling Marine Terminal Trucks Monthly Inspection Activity," www.baaqmd.gov/enf/idling_truck/idling_trucks.htm. BAAQMD notes that decreased enforcement may be due to a decrease in wait times outside the terminal, or fewer complaints from drivers waiting outside the terminal. However, our observations on three different workdays found wait times to be substantial.

52 Ports of Long Beach and Los Angeles. "San Pedro Bay Ports Clean Air Action Plan," www.portoflosangeles.org/DOC/REPORT_Clean_Air_Overview_English.pdf.

53 Port of Oakland: Task Force. "Port of Oakland Maritime Air Quality Improvement Plan," www.portofoakland.com/pdf/maqip070611_08.pdf.