

Diesel Engine Exhaust

Diesel engine exhaust can cause lung cancer. Long-term exposure to diesel exhaust particles poses the highest risk of any toxic air contaminant evaluated by California's Office of Environmental Health Hazard Assessment. On average, long-term occupational exposures to diesel exhaust are associated with a 40 percent increase in the relative risk of lung cancer. California's Air Resources Board (CARB) estimates that about 70 percent of the cancer risk that the average Californian faces from breathing toxic air contaminants stems from diesel exhaust particles. Diesel exhaust also causes lung diseases such as asthma, and it may damage the immune system, increasing the risk of allergies.

Health
Hazard
Advisory

What is diesel exhaust?

Diesel engine exhaust is a mixture of thousands of different gases and tiny particles. The particles are most important. They include polycyclic aromatic hydrocarbons (PAHs) and metals such as nickel and arsenic (these are known causes of human cancer). Most diesel particles are small enough to be inhaled deep into the lungs, where they pose the greatest hazard. Diesel exhaust contains 20 times more particles than gasoline exhaust does. Some of the main toxic gases in diesel exhaust are nitrogen oxides, sulfur oxides, and carbon monoxide.

How diesel exhaust affects your body

CANCER. Diesel exhaust causes lung cancer. Based on animal tests and dozens of studies of exposed workers, the lung cancer risk for long-term highly exposed workers may be large, even when compared to most other workplace risks.

LUNGS. Diesel exhaust irritates the eyes, nose, throat, and lungs. It interferes with lung function. Diesel exhaust can also affect the immune system, making people more prone to allergic reactions and possibly more prone to infectious diseases. Both lung irritation and allergic reactions can cause asthma, or make asthma worse. Asthma is a very serious disease. Symptoms include shortness of breath, chest tightness, wheezing, and coughing. Some experts think that diesel exhaust in modern city air may be one main reason why asthma is becoming much more common in big cities.

PREGNANCY AND REPRODUCTIVE HEALTH.

We don't know whether diesel exhaust can affect pregnancy or reproduction in humans. Many tests have been done in animals, but the results have been mixed and uncertain. Many tests showed no effects, but some suggested various effects on sperm, ovulation, or fetal development. Some of the substances in diesel exhaust (such as PAHs and carbon monoxide) can harm a developing baby if exposure is great enough, so pregnant women should avoid high exposure when possible.

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NOVEMBER 2002

California Department of Health Services • California Department of Industrial Relations

Reducing exposure

By law, employers must provide a safe and healthy workplace. Here are some things that employers and workers can do to reduce the amount of diesel exhaust that workers breathe.

Change the Fuel or the Engine.

- ▶ Reformulated diesel fuels (with lower sulfur and aromatics) or biodiesel fuel can reduce diesel exhaust emissions.
- ▶ Natural gas works well in heavy-duty trucks and buses. It meets all state and federal standards for the year 2004. Many cities use natural gas vehicles in their city fleets.
- ▶ Electricity works best for light or medium trucks and buses, short runs, and indoor use.
- ▶ Low-emission diesel engines with exhaust gas recirculation, improved fuel injection, and other improvements burn fuel more efficiently.

Install Vehicle Accessories That Reduce or Re-direct Diesel Exhaust.

- ▶ Exhaust extenders that re-direct the exhaust away from the operator.
- ▶ After-treatment devices such as diesel exhaust filters and oxidation catalytic converters.

Ventilate Indoor Work Areas.

- ▶ Place fixed diesel engines in separate, ventilated areas under negative air pressure.
- ▶ Use mechanical ventilation systems to pull diesel exhaust-contaminated air away from workers and exhaust it outdoors.
- ▶ Slip exhaust extractor hose attachments on the tailpipes of vehicles that must idle for long periods of time (such as in vehicle maintenance shops).
- ▶ Run diesel engines outdoors rather than indoors when possible.
- ▶ Don't run diesel engines near the air intake of building ventilation systems.

- ▶ Open doors and windows of work areas to let in fresh, uncontaminated air whenever possible (but this is often of limited use).

Ventilate Booths (Toll, Weigh Station, Border Inspection, etc.).

- ▶ Install a ventilation system that flushes the booth with clean, uncontaminated air.

Use Safe Work Practices.

- ▶ Maintain engines to ensure that they are functioning properly and emitting as little exhaust as possible. Conduct regular tune-ups and checks to detect leaking exhaust.
- ▶ Reduce engine idling time. Start engines only when necessary, and turn them off whenever it's practical. This is the most effective way to reduce exposure to diesel exhaust. Exhaust is still being emitted whenever engines are idling. Reducing idling time also saves money on fuel.
- ▶ Don't tamper with engines to improve fuel economy. It increases diesel exhaust emissions, and it's illegal.
- ▶ Check the bodies of vehicles. Seal cracks or holes with weather stripping to keep exhaust from getting into the cabin.
- ▶ Increase the distance between you and the source of the diesel exhaust whenever practical.
- ▶ Use a respirator only if ventilation and other control methods are not effective and feasible (California Code of Regulations, Title 8, Section 5144).

Participate in Incentive Programs.

- ▶ For example, the Carl Moyer Program administered by CARB will help pay for cleaner engines for on-road heavy-duty engines over 14,000 pounds gross vehicle weight. Interested persons should contact their local air district.

SPECIFIC WAYS TO REDUCE EXPOSURES FOR VARIOUS OCCUPATIONS

MECHANICS

- ▶ Use exhaust extractor hose attachments on tailpipes to carry exhaust outdoors.
- ▶ Run engines only when necessary, preferably outdoors.
- ▶ Open all windows to get fresh air into the work area.
- ▶ Distance yourself from the source of the exhaust.
- ▶ Get hands-on training in basic troubleshooting and repair skills in the one-day ARB training (see “Where to Get Help”).

UNDERGROUND MINERS

- ▶ Switch to electric vehicles where possible.
- ▶ Ensure good ventilation in the work area.
- ▶ Install exhaust filtration devices such as exhaust extenders, disposable diesel exhaust paper filters, and catalyzed or uncatalyzed diesel particulate ceramic filters.
- ▶ Do regular maintenance of the intake air cleaner or filter to reduce engine emissions.

BUS AND OTHER HEAVY-DUTY VEHICLE DRIVERS AND OWNERS

- ▶ Use vehicles that use natural gas, low-sulfur diesel, or other cleaner fuels.
- ▶ Use diesel particulate filters.
- ▶ Prepare your vehicle to pass the heavy-duty vehicle inspection program and periodic smoke inspection program, as well as to meet increasingly tough nitrogen oxides and particle emission standards.
- ▶ Make sure leased vehicles meet current and upcoming regulations.
- ▶ Maintain cab integrity.

TOLL BOOTH OPERATORS, TRUCK WEIGHING STATIONS, AND BORDER INSPECTION OFFICERS

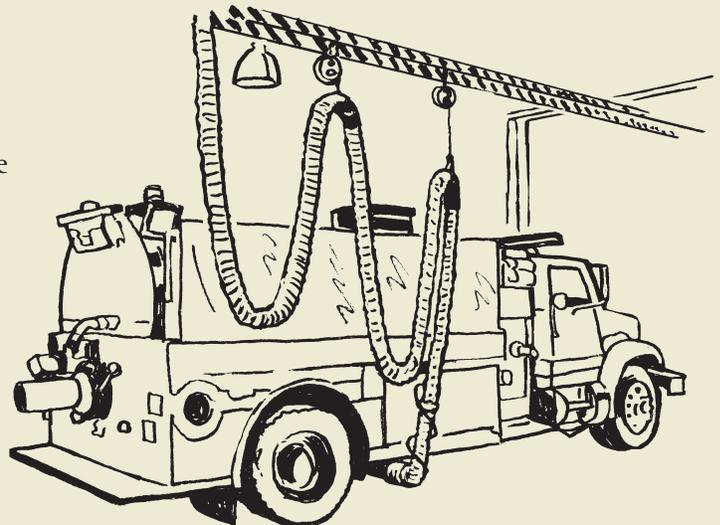
- ▶ Install a fresh-air ventilation system in the booth.
- ▶ Increase the distance from the source of the exhaust when possible.
- ▶ Have drivers shut off engines rather than idling for very long periods.

FIREFIGHTERS (IN FIRE STATIONS)

- ▶ Attach fall-away tailpipe exhaust hoses to trucks while idling indoors.
- ▶ Provide fresh air ventilation both to apparatus floor and to living areas.
- ▶ Keep living areas under positive air pressure.
- ▶ Weather-strip doors that separate living quarters from apparatus floor. Keep doors between apparatus floor and living areas closed.

CONSTRUCTION AND FARM WORK

- ▶ Do regular maintenance on vehicle engines.
- ▶ Don't idle engines any more than necessary.
- ▶ Maintain cab integrity.



Recommended exposure limits

Based on the risk assessment performed by Cal/EPA's Office of Environmental Health Hazard Assessment, exposure to 20 $\mu\text{g}/\text{m}^3$ of diesel particles over a working lifetime would create an excess lung cancer risk of one in a thousand, which is often used as an upper limit of acceptable workplace risk. HESIS recommends that exposures be kept below 20 $\mu\text{g}/\text{m}^3$.

The **American Conference of Governmental Industrial Hygienists (ACGIH)**, a private organization, has proposed a recommended workplace exposure limit of 20 $\mu\text{g}/\text{m}^3$ of diesel exhaust particles ("elemental carbon").

Legal exposure limits

Cal/OSHA (California's Division of Occupational Safety and Health) sets and enforces limits for exposure to chemicals in the workplace. Currently, there is no Permissible Exposure Limit (PEL) either for diesel exhaust itself, or for the tiny particles that are probably the most important part of diesel exhaust. There are PELs for some other main components of diesel exhaust, such as carbon monoxide and polycyclic aromatic hydrocarbons (PAHs), but they do not protect against the lung cancer risk from diesel exhaust.

The **U.S. Mine Safety and Health Administration (MSHA)** limits the amount of diesel exhaust particles ("total carbon") in underground non-coal mines to 400 micrograms per cubic meter of air (400 $\mu\text{g}/\text{m}^3$). In 2006 this limit will drop to 160 $\mu\text{g}/\text{m}^3$.

State and federal environmental protection agencies enforce various laws and regulations to minimize diesel emissions. In California, regulations require use of low-sulfur fuel, reduction of nitrogen oxides and particles, and use of alternative fuels. Regulations cover both on-road and non-road vehicles. These regulations are for environmental protection, not worker protection. For more information, contact the California Air Resources Board (see "Where to Get Help").

The **U.S. Environmental Protection Agency** limits the small-particle exposure of the general population in each region to 15 $\mu\text{g}/\text{m}^3$, as an annual average, not to exceed 50 $\mu\text{g}/\text{m}^3$ during any given 24-hour period. This environmental regulation, for all particles and not just diesel particles, is enforced by the Air Resources Board and does not directly affect the workplace.

Measuring your exposure

If you think you might have significant diesel exhaust exposure at work, talk to your supervisor and/or your union. If any worker might be exposed to a substance at more than the legal exposure limit, the employer must measure the amount of the chemical in the air in the work area (California Code of Regulations, Title 8, Section 5155). An industrial hygienist can measure the amounts of carbon monoxide, PAHs, and particulates in your workplace air. You have the right to see the results of such monitoring relevant to your work (Title 8, Section 3204). It is probably better to measure fine elemental carbon; there is not yet a legally enforceable standard for it, but the monitoring results can be compared to the recommended exposure limit of 20 $\mu\text{g}/\text{m}^3$.

Medical tests for exposure and effects

There is no medical test to measure the amount of diesel exhaust you've been exposed to. Your body quickly gets rid of most diesel exhaust gases. Your lungs also remove the particles, though not as quickly.

HESIS recommends that workers exposed to diesel exhaust have baseline pulmonary function tests (PFTs). PFTs measure how well your lungs move air. If you develop breathing symptoms, comparing a baseline PFT to follow-up PFTs is important in evaluating your lung function change. A simple form of PFTs is called spirometry. Spirometry can be done both before and after a single work shift to tell whether lung function is affected by your work. For a worker with breathing symptoms or an unexplained change in periodic PFTs, this pre- and post-shift testing can be very valuable. HESIS can provide a spirometry fact sheet.

You have the right to see and copy your own medical records, and any records of exposures to toxic substances. These records are important in determining whether your health has been affected by your work. Employers who have such records must keep them and make them available to you for at least 30 years after the end of your employment.

DOES YOUR WORK EXPOSE YOU TO DIESEL EXHAUST?

Most Americans are exposed to some diesel engine exhaust, but some jobs involve much higher exposure.

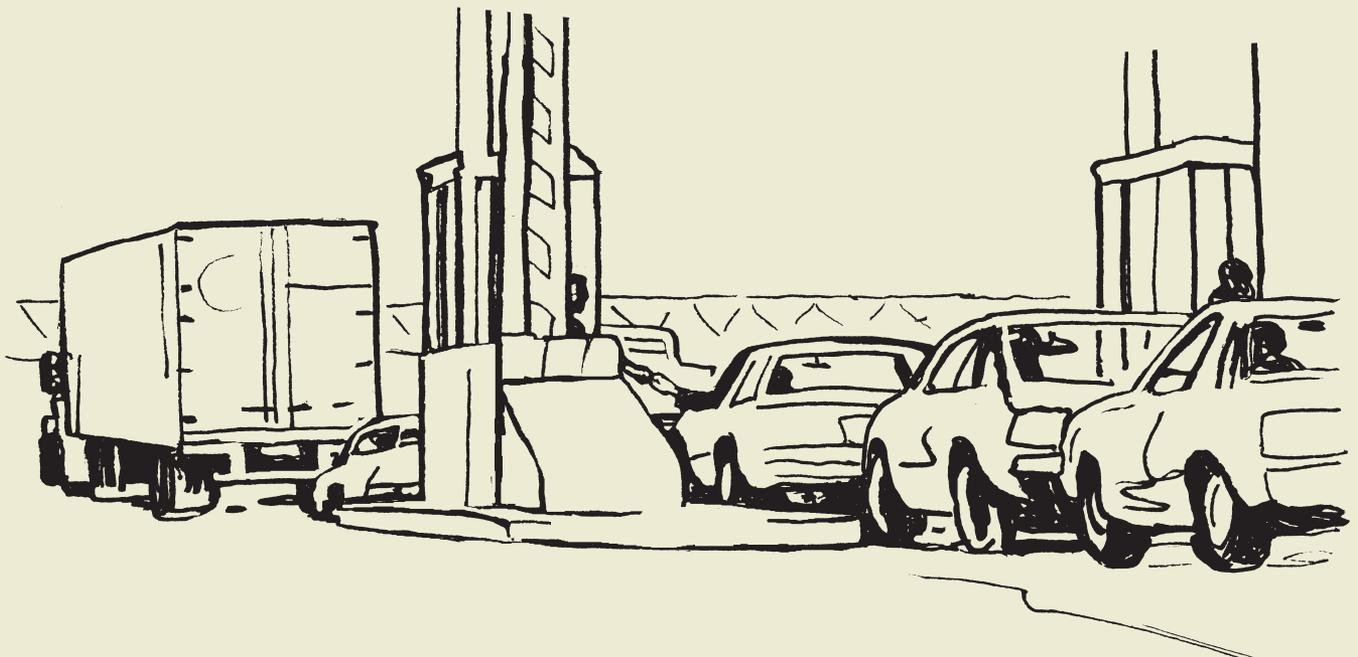
The highest exposures are in jobs where diesel engines are running indoors.

These include working...

- as a diesel engine mechanic,
- in bus barns,
- in fire stations, and
- in mining operations where diesel equipment is used.

Other highly exposed workers include:

- operators of diesel powered engines (such as in trains, trucks, buses, tractors, and forklifts),
- toll booth workers,
- roadside inspection workers, and
- workers in some oil and gas production areas, railroad yards, and loading/shipping docks.



WHERE TO GET HELP

➤ The **California Air Resources Board** has information about emission control technologies, alternative fuel formulations, air quality regulations, incentive programs, etc. Contact ARB at www.arb.ca.gov, 800/242-4450 (statewide) or P.O. Box 2815, Sacramento, CA 95812.

➤ The **U.S. Department of Energy Alternative Fuels Data Center** at www.afdc.doe.gov has information on alternative fuels and vehicles. It also has listings of available alternative fuel vehicles, links to related websites, and more than 3,000 documents in its database.

➤ **HESIS** answers questions about workplace hazards and has many free publications available.

For information on workplace hazards: (510) 622-4317. Please leave a message and your call will be returned.

For HESIS Publications: (510) 622-4328. Call, or visit our website www.dhs.ca.gov/ohb, or write to HESIS, 1515 Clay Street, Suite 1901, Oakland, CA 94612.

- *Pulmonary Function Testing Fact Sheet*. Explains how the lungs work and tests that can be used to identify lung disease.
- *n-Hexane Use in Vehicle Repair Health Hazard Advisory*. Helps mechanics identify and prevent nerve damage from n-hexane-containing brake and parts cleaners.
- *HESIS Publication List*. Fact sheets, booklets, medical guidelines, and technical documents on workplace hazards including chemicals, repetitive motion, and infectious diseases. Visit our website, call, or write for the list.

➤ **California Division of Occupational Safety and Health (Cal/OSHA)** investigates workers' complaints and answers questions about workplace health and safety regulations. Complainants' identities are kept confidential.

Contact the Cal/OSHA Enforcement District office nearest to your workplace. They are listed in the blue government section near the front of your local phone book under "State Government / Industrial Relations / Occupational Safety and Health / Enforcement" or visit their website at www.dir.ca.gov/DOSH/districtoffices.htm.

➤ **Other resources for employees** may include your supervisor, your union, your company health and safety officer, your doctor, or the company doctor.

➤ **Cal/OSHA Consultation Service** helps employers who want free, non-enforcement help to evaluate the workplace and improve the health and safety conditions. Employers can call (800) 963-9424.

➤ **Occupational health services** can be found at:

- UC San Francisco/SFGH Occupational and Environmental Medicine Clinic: (415) 885-7580.
- UC Davis Occupational and Environmental Medicine Clinic: (530) 754-7635.
- UC Irvine Center for Occupational and Environmental Health: (949) 824-8641.
- UC San Diego Center for Occupational and Environmental Medicine: (619) 471-9210.



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