

TITLE: The Dangers of Diesel Exhaust in the Fire Station

TIME REQUIRED: 2 hours

MATERIALS: Easel pad and markers, or board and chalk, Power-Point Projector, computer with internet access (if using video clips).

There are several reports available on the following web sites:

References

- National Institute of Occupational Safety and Health (NIOSH) – In accordance with NIOSH pocket guide for chemical hazards and its documentation for immediately dangerous to life or health concentrations, NIOSH recommends (Appendix A) “vehicle exhaust fumes are a potential health carcinogen and recommends that occupational exposure to this carcinogen be lowered to the lowest feasible concentration.”
- Occupational Safety and Health Administration (OSHA) – Hazard Information Bulletin November 30, 1988 – “epidemiological evidence suggests an association between occupational exposure to diesel engine emissions and lung cancer. The consistency of these toxicological and epidemiological findings suggests that a potential occupational carcinogenic hazard exists in human exposure to diesel exhaust.”
- National Fire Protection Association (NFPA) 1500-2002 edition – A.9.1.6 which states “for the previously stated reasons and numerous support documentation, this technical committee recognizes and advocates the need for the elimination and the containment of all vehicle exhaust emissions to a level of no less than 100 percent effective capture.”

MOTIVATION:

Diesel exhaust, found in every fire station in America, is produced when an engine burns diesel fuel. It is a complex mixture of thousands of gases and fine particles (commonly known as soot) that contain more than forty toxic air contaminants. These include many known or suspected cancer-causing substances, such as benzene, arsenic and formaldehyde. It also contains other harmful pollutants, including nitrogen oxides.

The US Environmental Protection Agency (EPA) concluded in a report made public on Sept. 3, 2002 that long-term exposure to diesel engine exhaust (DE) in the air is linked to lung cancer.

OBJECTIVE: (SPO) 1-1:

Given information, resources, and an opportunity for discussion, at the completion of this lesson, the student will be able to understand the short and long term health effects of diesel exhaust exposure and make recommendations for controlling this exposure to diesel exhaust in fire stations.

Enabling Objectives

- EO: 1 Define the components of diesel exhaust
- EO: 2 Define what exposure levels of diesel exhaust are considered dangerous
- EO: 3 Describe the health effects of diesel exhaust exposure
- EO. 4 Review the risk management principles
 - Eliminate the hazard.
 - Substitute with a lesser hazard.
 - Use engineering controls to reduce hazard
 - Administrative controls (workplace procedures).
 - Personal Protective Equipment.

Overview

- Components of diesel exhaust
- Exposure levels of diesel exhaust
- The health effects of diesel exhaust exposure
- Risk Management Principles

I. Components

A. *Diesel exhaust is composed of two parts*

1. Diesel engines have become the most widely used portable power source in recent years. This had caused increased exposure to diesel fumes and exhaust more prevalent to workers and pedestrians alike because of the wide spread use of diesel engines in the transportation sector of our economy.
2. In considering the potential health effects arising from exposure to diesel exhaust, it is helpful to view the exhaust as being composed of two parts, gaseous and particulate. The gaseous phase of diesel exhaust is composed of carbon monoxide, oxides of sulfur and nitrogen, and unburned or partially burned hydrocarbons.
3. The microscopic solids mainly consist of unburned fuel and oil in addition to other possible 18,000 substances that are attached to carbon atom and is referred to as diesel particulate matter (DPM)

B. *Statistics – how big is the problem*

1. Diesel exhaust has been shown to contain 20 to 100 times more fine particles than exhaust produced from a comparable size gasoline engine. The fine particles carry with them the known cancer causing chemicals poly nuclear aromatic hydrocarbons. The noxious gases produced are also damaging to humans and the surrounding environment
2. These particulates are small in size, easily inhaled and contain many different chemicals. The chemicals gather on the surface of the particulates and represent 15-65% of the mass of the particles. The remainder of the particles is made of carbonaceous material potential health hazards.

II. Exposure Limits

A. Diesel Particulate Matter Exposure Levels

1. There is no federal regulation for levels of diesel exhaust or diesel particulate matter in buildings. EPA provides a Reference Concentration (RfC) recommending maximum long-term exposure

to diesel particulates at $0.05\text{mg}/\text{m}^3$. This is not a regulation and cannot be enforced, but does provide a level that could present a hazard to individuals experiencing chronic exposure. Especially susceptible people may be affected at lower levels. According to NIOSH levels of DPM in fire stations ranges from 0.1 to $0.48\text{mg}/\text{m}^3$. Fact sheet

http://www.epa.gov/air/tribal/attachmts/de_factsheet_8_29_02.pdf ; full study available

<http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=29060>.

2. OSHA in *29 CFR § 1910.1000* lists “Toxic and Hazardous Substances” and maximum allowed exposure during eight hour shift. Diesel exhaust and diesel particulate matter are not on the list, although some constituents of diesel emissions are regulated. For example, particulate matter can be classified as respirable dust limit of which is $5\text{mg}/\text{m}^3$.

B. Presumptions and Legal Case

1. EPA has been engaged in a review of the health effects of diesel exhaust since 1990. Finally, after an exhaustive review of five earlier draft documents, EPA has issued a final version of its “Health Assessment Document for Diesel Engine Exhaust.” The EPA health assessment concludes that long-term inhalation exposure is likely to pose a lung cancer hazard to humans. The document falls short of quantitatively defining the cancer risk to humans in terms of a “unit risk” number.
2. A study about the exposure of firefighters to diesel exhaust has been conducted. Personal sampling techniques were used to evaluate firefighter exposure to particulates from diesel engine exhaust.
3. Fire stations in New York, Boston and Los Angeles were studied. The more alarms firefighters responded to, the higher their exposure to diesel exhaust particulates.

When there were between 7 and 15 alarms during an 8 hour shift, the exposure levels of total airborne particulates from diesel exhaust ranged from 170-480 ug/m³ (micrograms per cubic meter of air) averaged over eight hours.

4. In *Culbert v. City of Jersey City*, 175 N.J. 286, 291, (2003), a Judge determined a study concluding that exposure to diesel exhaust increases risk of lung obstruction was persuasive. In *Culbert* plaintiff was awarded worker's compensation benefits ruling that occupational exposure as firefighter for thirty years materially contributed to the development of pulmonary disease. The Judge did not specifically state that diesel exhaust contributed to disability but that it could increase chances of pulmonary disease.

III. DE Health Effects

A, Short Term

1. Diesel exhaust is composed of gases and microscopic solids. The most significant gases are carbon monoxide (CO), carbon dioxide (CO₂), hydrocarbons (HC), nitrogen oxides (NO₂), and sulfide oxides (SO₂).
 - a. Carbon Dioxide (CO) upon entering the bloodstream reduces delivery of oxygen to the body's organs and tissues.
 - b. Exposure from diesel exhaust can cause a series of temporary symptoms including: headaches, eye irritation, nausea, vomiting, numbness, wheezing, heartburn and chest tightness Hydrocarbon (HC) contributes to formation of ozone, which is responsible for choking, coughing, and stinging eyes associated with smog.
 - c. Sulfide Oxides (SO₂) causes eye and mucous membrane irritation.

B. Long Term

1. Ozone damages lung tissue aggravates respiratory disease and makes people more susceptible to respiratory infections. Children are especially susceptible to ozone's harmful effects, as adults with existing disease.
 - a. Many hydrocarbons (HC) are also air toxins. Exposure to air toxins is associated with cancer, birth defects and other serious health problems.
 - b. Nitrogen Oxides (NO₂) can irritate lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections.
 - c. Particulate Matter (PM) causes breathing and respiratory problems, aggravation of existing respiratory and cardiovascular disease, damage to lung tissue, alteration in immunological system, and premature death.
 - d. High exposure to CO₂ can cause poisoning and death

IV. Risk Management Principles / DE Exposure Controls

A. Risk Management Principles

1. Eliminate the Hazard
 - a. Particulates from diesel exhaust in fire stations can exceed background (ambient) levels. Since diesel exhaust presents some carcinogenic risk, it is important to minimize the exposure of firefighters.
 - b. The National Fire Protection Association (NFPA) Standard, Fire Department Occupational Safety and Health Program (NFPA 1500-1992) states, "Fire stations shall be designed and provided with provisions to ventilate exhaust emissions from fire apparatus to prevent exposure to firefighters and contamination of living and sleeping areas."
 - c. NIOSH tests indicate that departments that replaced trucks had significantly lower concentration of diesel exhaust in

buildings. *A Summary of Health Hazard Evaluations: Issues Related to Occupational Exposure to Fire Fighters, 1990 to 2001.* p. 9. Although truck replacement will reduce emissions, it is very expensive and similar results can be achieved by filter installation.

2. Substitute with a lesser hazard

- a. Commercially available high efficiency filter systems can be used to filter out particulates emitted from diesel engines. One system consists of a filter, a diverter unit, and an electronic control module, all of which are completely self-contained on the vehicle. This enables the filter system to be operated at anytime, regardless of the vehicle's location.
- b. EPA has Voluntary Diesel Retrofit Program, which provides assistance in retrofitting trucks for lowering emissions. Retrofitting is the installation of equipment in the exhaust line that combined with ultra low sulfur diesel (ULSD) can reduce emissions up to 90%. Use of ultra low sulfur diesel increases the effectiveness and longevity of the equipment.
- c. Biodiesel will provide significant emission reductions for some pollutants and slight increases in others. It can be used and will provide emissions reductions in new trucks.

3. Use engineering controls to reduce hazard

- a. Diesel exhaust infiltration can be reduced by maintaining living quarters and office areas under positive pressure.
- b. Ventilation systems should be installed to control vehicle exhaust. The two types of ventilation systems which may be used are dilution and local. Local exhaust is preferable because it removes the diesel exhaust at the source.

1) Dilution Ventilation

- a) Hot exhaust emissions rise, therefore, exhaust fans should be located near the ceiling and exhausted outside.
- b) The volume of exhaust emissions generated is dependent on the number of trucks in operation in the firehouse and the horsepower of the trucks. The American Conference of

Governmental Industrial Hygienists recommends dilution ventilation rates of 100 cubic feet per minute (cfm) per horsepower for diesel engines that are idling.

- c) Make-up air must be supplied to replace exhausted air.
- d) The exhaust opening should be situated to prevent re-entry of exhaust through windows or fresh air intakes.

2) Local Exhaust Ventilation

- a) An exhaust filter hose system should be connected to the tail pipe of the truck. It should remain on the tail pipe until the truck has left the building.
- b) Make-up air must be supplied to replace exhausted air.
- c) The exhaust opening should be situated to prevent re-entry of exhaust through windows or fresh air intakes.

4. Administrative controls (workplace procedures).

- a. Proper truck maintenance is important to reduce emissions. Maintenance should include all parts of the vehicle. A NIOSH study found that trucks with leaking air brakes run a minute longer, unnecessarily emitting pollutants. *A Summary of Health Hazard Evaluations: Issues Related to Occupational Exposure to Fire Fighters, 1990 to 2001. p. 10*

Some maintenance problems can be identified from smoke colors. Blue and black smoke indicates engine problems. Blue smoke (mainly oil and unburned fuel) indicates a poorly serviced and/or tuned engine. Black smoke (soot, oil and unburned fuel) indicates a mechanical fault with the engine. White smoke (water droplets and unburned fuel) is produced when the engine is started from cold and disappears when the engine warms up.

- b. Work practices and procedures should be established and enforced to ensure the following:
- 1) Garage doors should be opened before engines are started and vehicles should not be allowed to idle in the fire station.
 - 2) All drivers should be instructed to keep vehicular operation to an absolute minimum in the fire station. Exhaust hoses should be connected to apparatus to assure operational readiness
 - 3) Garage doors should be left open, when weather conditions permit, for at least 10 minutes following the operation of the vehicles.
 - 4) Doors leading directly from the garage to other areas of the fire station should be kept closed whenever possible. Consideration should be given to installing an automatic door closing device.
 - 5) All doors leading from the garage to stairwells, hose towers, living quarters, kitchen or offices should be modified by the addition of weather stripping (or similar material) in order to prevent diesel exhaust infiltration

Summary

Given information, resources, and an opportunity for discussion, at the completion of this lesson, the student will be able to list the hazards associated with diesel exhaust exposure, the short and long term signs and symptoms associated with acute and cumulative exposure and by employing the risk reduction principles model, identify possible solutions to reduce or eliminate these dangerous exposures.

Review:

- Define the components of diesel exhaust

- Define what exposure levels of diesel exhaust are considered dangerous

- Describe the health effects of diesel exhaust exposure

- Review the risk management principles

 - Eliminate the hazard.

 - Substitute with a lesser hazard.

 - Use engineering controls to reduce hazard

 - Administrative controls (workplace procedures).

 - Personal Protective Equipment.