

# Adverse Health Effects Associated With Exposure to Diesel Emissions



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# Topics

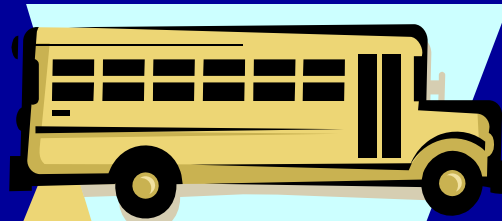
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# Diesel Exhaust Description

- A broad range of diesel engines; such as the on-road diesel engines of trucks, buses, and cars and the off-road diesel engines of locomotives, marine vessels, and heavy-duty equipment, emit diesel exhaust.
- Diesel exhaust consists of two phases: a gas phase and a particulate phase. Both phases contribute to the risk to human health.

# Diesel Exhaust Description

- The gas phase consists of many air toxics found in the urban environment; such as, acetaldehyde, acrolein, benzene, 1,3-butadiene, formaldehyde, and the polycyclic aromatic hydrocarbons.
- The particulate phase consists of fine and ultrafine particles of carbon to which organic compounds, sulfates, nitrates, metals, and other trace elements are adsorbed.



# Adverse Human Health Effects

- Gas Phase

Short-term exposures to acetaldehyde, acrolein, benzene, 1,3-butadiene, and formaldehyde are associated with these **non-cancer** effects:

- Irritation of the eyes, skin, and upper and lower respiratory tract;
- Respiratory symptoms like difficult breathing, coughing, and sneezing;
- Lung congestion, and
- Drowsiness, dizziness, and headaches (only benzene).

# Adverse Human Health Effects

- Gas Phase

Life-time exposures to acetaldehyde, benzene, 1,3-butadiene, formaldehyde, and polycyclic aromatic hydrocarbons may be associated with **cancer**.

- Acetaldehyde is a *probable* human carcinogen;
- Benzene is a *known* human carcinogen;
- 1,3-Butadiene is a *known* human carcinogen;
- Formaldehyde is a *probable* human carcinogen;
- Polycyclic aromatic hydrocarbons are *probable* human carcinogens.

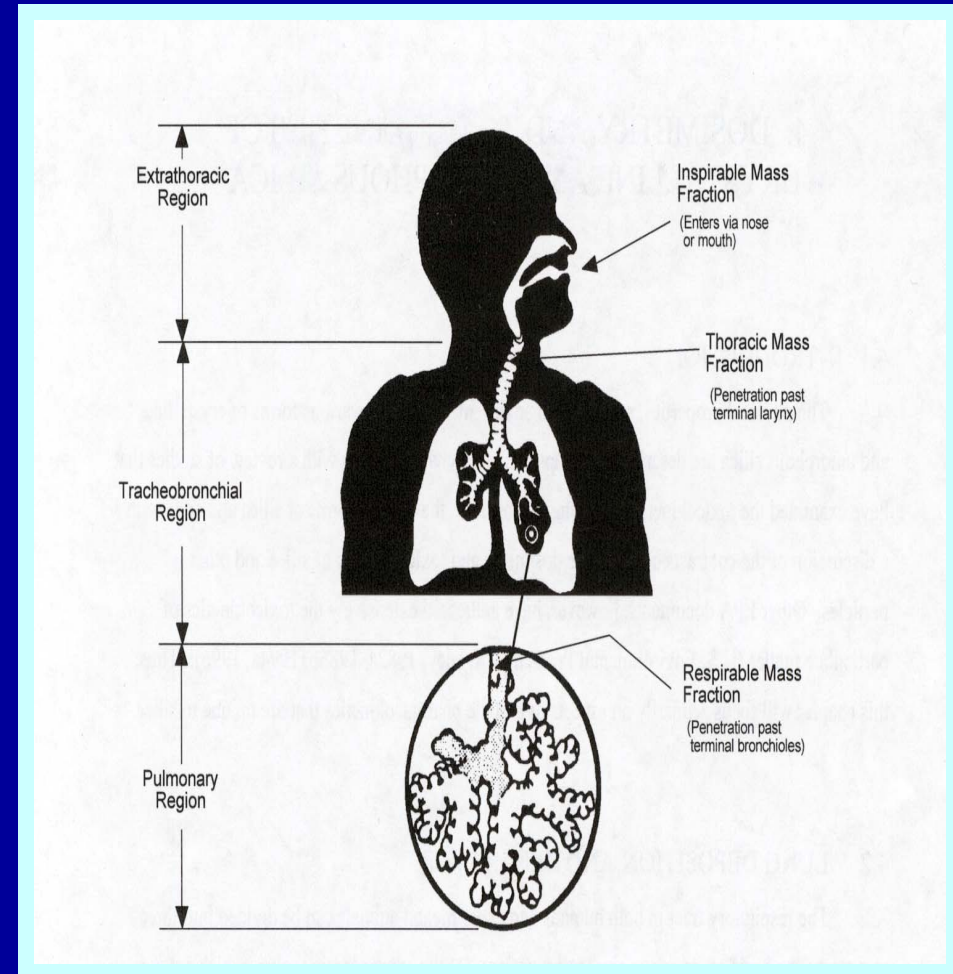
# Adverse Human Health Effects

- Particulate Phase

The particulate phase consists of fine and ultrafine particles of carbon that have diameters between 1 and 10 micrometers. As a point of comparison, fine beach sand has an average diameter of 90 micrometers and human hair has an average diameter of 70 micrometers.

# Adverse Human Health Effects

- Fine particles ( $>10\ \mu\text{m}$ ) deposit in the upper respiratory tract. →
- Ultrafine particles ( $\leq 10\ \mu\text{m}$ ) penetrate deeply into the lungs. →
- The lungs may clear, accumulate, attack, or absorb particles.



# Adverse Human Health Effects

- Particulate Phase

Many scientific studies link breathing particle pollution to a series of significant health problems including:

- Aggravation of asthma;
- Increased respiratory symptoms like coughing and difficult breathing;
- Chronic bronchitis; and
- Decreased lung function.

# Adverse Human Health Effects

- Diesel Exhaust

Short-term studies consistently showed the **non-cancer** effects of inflammation, fibrosis, and structural and functional changes in the pulmonary and tracheo-bronchial regions of laboratory animals exposed to diesel exhaust. U.S. EPA considers these non-cancer effects relevant to human beings.

There is growing evidence suggesting exposure to diesel exhaust exacerbates asthma.

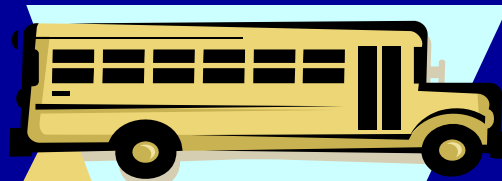
# Adverse Human Health Effects

- Diesel Exhaust

In 1999, U.S. EPA recognized diesel exhaust as *likely to be carcinogenic to humans* via inhalation from environmental exposure. The weight of the evidence indicated that diesel exhaust has the potential to pose a lung cancer hazard to human beings at anticipated levels found in the environment. Four lines of evidence support this recognition.

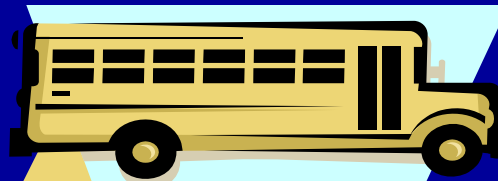
# Adverse Human Health Effects

- Diesel Exhaust - Four Lines of Evidence
  1. Strong but insufficient evidence for a causal association between diesel exhaust exposure and increased lung cancer risk among exposed workers.
  2. Demonstrated mutagenic and/or chromosomal effects of diesel exhaust and its adsorbed organic compounds.
  3. Evidence of carcinogenicity for diesel particulate matter and its adsorbed organic compounds in rodents via other routes of exposure.
  4. Suggestive evidence for the bioavailability of diesel exhaust's adsorbed organic compounds in human beings and animals.

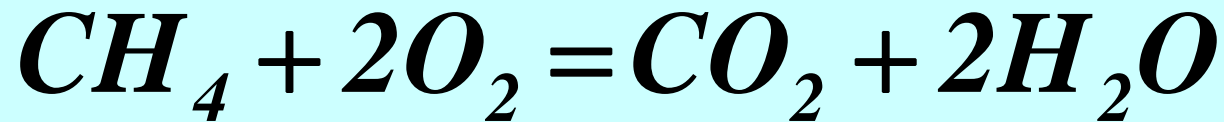


# Other Health and Environmental Effects

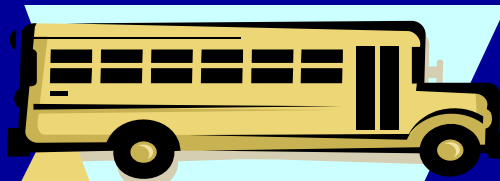
- Diesel exhaust also contains pollutants that contribute to ozone formation, acid rain, and global climate change.



# Idling is a Harmful Practice

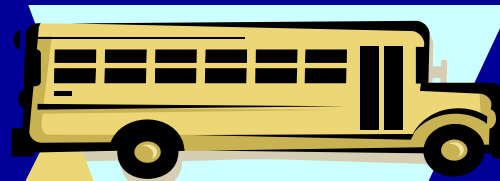


- The chemical equation above represents an efficiency of 100 percent fuel combustion.
- Idling reduces the efficiency of fuel combustion.
- A result of idling is the greater release of particles of incomplete combustion and un-combusted fuel.



# Children's Exposure to Diesel Exhaust

- Compared to adults, children may be more vulnerable to diesel exhaust because:
  - Their behavior and activities increase their exposure to diesel exhaust,
  - With respect to body size and weight, they breathe more air, and
  - Their bodily systems and functions are incomplete and immature.

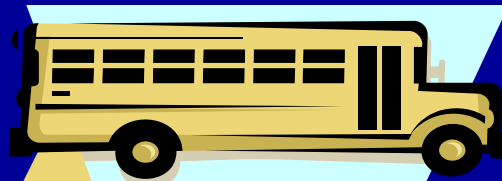


# Lessons Learned

- Diesel engines emit exhaust that is hazardous to human health and the environment.
- Diesel exhaust contains chemicals that cause eye and skin irritation; respiratory irritation, symptoms, and congestion; and adverse central nervous system effects.
- Diesel exhaust contains both *probable* and *known* human carcinogens.
- Exposure to diesel exhaust may exacerbate asthma.
- Diesel exhaust is *likely to be carcinogenic to humans* via inhalation from environmental exposure according to U.S. EPA.

# Lessons Learned

- Diesel exhaust contains chemicals that cause other health and environmental effects.
- Diesel engine idling reduces fuel combustion efficiency, increasing the release of particles of incomplete combustion and un-combusted fuel.
- Children are a sensitive and susceptible subset of the human population.



# The Challenge Ahead

- Protecting children's health from environmental risks is a fundamental task to the mission of the Missouri Department of Natural Resources.
- The Clean School Bus USA program represents a step toward reducing exposure to, and the cancer and other adverse health effects associated with, diesel exhaust.
- The Department views this program as a natural fit in its mission and welcomes others to participate in its implementation.

