For Internal Agency Use Only –September 2002

Health Assessment Document for Diesel Exhaust
Questions and Answers

The following questions and answers provide general information and a summary of key points in EPA's Health Assessment Document for Diesel Exhaust released in September 2002. It also includes information not covered in detail in this Health Assessment Document, such as information on general ambient PM, the National-Scale Air Toxics Assessment, and steps communities can take to reduce exposure to diesel exhaust.

1. What regulations has EPA issued to control diesel exhaust emissions?

Over the years, EPA has issued increasingly stringent regulations to control particulate matter from diesel-powered highway and non-road vehicles and equipment. The most recent regulations, effective with the 2007 model year, will result in well over 90% control of diesel particulate matter from highway diesel trucks and buses. As a result, non-road diesel engines, already a major source of diesel particulate matter, will become its dominant source in the future. EPA is currently considering what additional controls on these sources would be appropriate.

These regulations also reduce nitrogen oxide emissions from diesel engines.

2. What impact will these regulations have on health effects associated with diesel exhaust?

These regulations to take effect in 2007 will significantly decrease diesel exhaust emissions such as $PM_{2.5}$ and nitrogen oxides. Also, the composition of the exhaust will change as these emissions are controlled.

When fully implemented by roughly 2030, EPA estimates these regulations will prevent on an annual basis:

- 8,300 premature deaths;
- 5,500 cases of bronchitis and 17,600 cases of acute bronchitis in children;
- more than 360,000 asthma attacks in children;
- 7,100 hospital admissions and 2,400 emergency room visits for asthma;
- more than 386,000 cases of respiratory problems in children;
- over 1,500,000 lost work days; and
- nearly 10 million days of restricted activity due to acute respiratory symptoms.

3. What are the major conclusions in the Health Assessment Document for Diesel Exhaust?

The assessment presents three major conclusions regarding the potential for health hazards resulting from exposure to diesel engine exhaust:

- Long term exposure to diesel exhaust is likely to pose a lung cancer hazard to humans
- Long term exposure to diesel exhaust may result in chronic non-cancer health effects in the respiratory system
- Short term exposure to diesel exhaust can result in irritation of the respiratory system and neurophysical sensory organs. These effects are not necessarily long lasting.

4. Will diesel exhaust cause cancer?

Diesel exhaust is "likely to be carcinogenic to humans" based on a number of scientific studies (called epidemiologic studies) of worker groups exposed to diesel exhaust for many years. EPA judged that the diesel lung cancer hazard seen in the worker studies applies to environmental exposure conditions. EPA describes the carcinogenicity evidence according to the amount of data available and its quality by using descriptive phrases such as "carcinogenic to humans", "likely to be carcinogenic to humans", "suggestive evidence of carcinogenicity", and "not likely to be carcinogenic to humans."

5. How carcinogenic is diesel exhaust? Is it more potent than other carcinogens?

While the health data are suitable to establish that diesel exhaust is likely to be carcinogenic to humans, they are not adequate to confidently determine a carcinogenic potency (i.e., a quantitative dose/response assessment of carcinogenic risk per unit of exposure). Without a potency estimate, it is not possible to directly compare diesel exhaust with other substances whose potencies have been estimated. Much of the human health data comes from motor vehicle operators, repair personnel, truck drivers, railroad workers, heavy equipment operators, and transport workers exposed to diesel exhaust where the actual exposure levels were not measured at the time of the original exposure. Since worker exposure was generally not measured and later efforts to quantify the exposure based on estimates may not be accurate, it is not possible to confidently determine the relationship of exposure and the observed increase in lung cancer. This is a key relationship that is needed to predict the potency and subsequent estimates of risk for the general population.

6. Since a carcinogenic potency cannot be calculated, is there another way to gain a sense of how significant the lung cancer hazard might be?

The Health Assessment Document provides a discussion of "possible" risk levels to the general public, called a "perspective on risk," to illustrate and gauge how significant the cancer hazard might be. The discussion was caveated as exploratory and not suitable to estimate cancer cases.

A range of possible risks to the general public was discussed. On the one hand, analysis showed that it was possible for risk levels to be greater than 1 in one hundred thousand (10^{-5}), and therefore, of interest to EPA's regulatory objectives to protect human health. Risks could also be as high as 1 in one thousand (10^{-3}) over a lifetime of exposure. EPA was clear to say that lower risks were possible and a zero risk could not be ruled out. In general, EPA does not consider sources for regulation when the risks are lower than one in one million (10^{-6}).

7. Does diesel exposure pose any other health risks from chronic exposure?

Long-term exposure to diesel exhaust poses a noncancer hazard to the respiratory system based on evidence of lung damage in animals exposed for a lifetime to levels of diesel exhaust that are higher than those found in the environment. Examples of these effects are altered pulmonary function and increases in susceptibility to respiratory tract infection. Similar types of adverse effects have also been associated with exposure to ambient particulate matter, of which diesel particulate matter is a ubiquitous part.

8. How do the non-cancer effects of concern from exposure to diesel exhaust compare to those associated with $PM_{2.5}$?

Ambient fine particles -- those less than 2.5 microns in diameter ($PM_{2.5}$) -- have been associated with an increased risk of premature mortality, hospital admissions for heart or lung disease, increased respiratory symptoms, and other adverse effects. Diesel particles are a constituent of the ambient PM mix. Evidence is emerging that diesel exhaust exacerbates existing allergies and asthma. The exacerbation of asthma has also been associated with exposure to ambient PM. EPA has established National Ambient Air Quality Standards for particulate matter ($PM_{2.5}$) to protect the public from adverse health effects.

9. What are the risks of short-term exposure to diesel exhaust?

Short-term exposure to diesel exhaust poses health hazards in the form of symptoms, not necessarily long lasting, related to irritation of the respiratory system and the neurophysiological sense organs (such as the nose, eyes). The susceptibility and severity of these symptoms varies widely across the population. Included in these symptoms are those related to increased allergic responses as well as symptoms consistent with asthma. While the effects are observable, the data were insufficient to develop a recommendation for safe levels of exposure for these types of health hazards.

10. What is the reaction of the scientific community to EPA's analysis of the diesel health data and its conclusions?

EPA had an independent panel of technical experts (the Clean Air Scientific Advisory Committee[CASAC]) review the report in public meetings and make recommendations to the Administrator on whether the report was scientifically acceptable and what changes would be useful. The CASAC agreed at a meeting in October 2000 that this complex document would be scientifically acceptable after incorporation of key aspects of their advice. EPA made those changes to the assessment.

Numerous other government agencies and health organizations have also already concluded that diesel particulate matter poses a potential or probable carcinogenic hazard, including the U.S. Department of Health and Human Services, National Institute of Occupational Safety and Health, International Agency for Research on Cancer, World Health Organization, and the California Environmental Protection Agency.

11. What other analysis has EPA conducted on air pollution impacts?

Separate from the Health Assessment Document for Diesel Exhaust, EPA performed a national-scale assessment (National-Scale Air Toxics Assessment) of health risks resulting from inhalation exposure to air pollutants, using modeled exposure levels and available information on air toxics health effects for a variety of air pollutants. The health risks for 33 air toxics were evaluated for each county in the United States. Mobile sources are responsible for about half of the emissions of air toxics included in the national-scale assessment. In this analysis, the potential risk from diesel exhaust emissions is not addressed in the same fashion as other pollutants because existing data are not sufficient to develop an estimate of carcinogenic potency. Thus it is not possible to directly compare cancer risk from diesel exhaust to that of other air toxics in a quantitative fashion. However, the results from the diesel assessment suggest that the potential hazard from diesel exhaust

ranks with other substances that the national-scale assessment shows as posing the greatest risk, such as benzene and formaldehyde.

12. What are the components of diesel exhaust?

Diesel exhaust consists of a number of components in either a gaseous or particle form. They include various hydrocarbons, carbon monoxide, nitrogen oxides, carbon dioxide, water vapor, and particulate matter (including black carbon). (Hydrocarbon compounds are those chemical constituents containing hydrogen and carbon; there are well over 100 such compounds in diesel exhaust. They can exist in the gas phase or be adsorbed onto the particulate).

13. How is diesel exhaust measured?

Diesel particulate is frequently used as a surrogate for diesel exhaust. Diesel particulate concentrations and exposure are obtained by measuring the weight of diesel exhaust particles present in the air. The specific unit of measurement is particle mass per cubic meter of air, which is the same measurement used for ambient particulate matter.

14. What is diesel particulate matter?

Diesel particulate matter is generally thought of as soot; it consists of black carbon with various hydrocarbon (organic) compounds adsorbed onto its surface. The particulate matter from diesel engines also contains sulfate compounds, which result from sulfur in diesel fuel. Diesel particulate matter is an ubiquitous constituent of ambient particulate matter (e.g., $PM_{2.5}$ - particulate matter that is 2.5 microns or smaller in diameter).

15. How large are the particles in diesel particulate matter?

The vast majority of particles emitted from diesel engines are less than 2.5 microns in diameter. By comparison, the average human hair is about 100 microns thick. EPA established a National Ambient Air Quality Standard for particulate matter ($PM_{2.5}$) in July 1997 to protect public health against these adverse effects.

16 What are some of the sources of particulate matter (other than diesel exhaust)?

There are many sources of $PM_{2.5}$ in the atmosphere other than diesel engines, including emissions from electric utilities, industrial fuel combustion, other fuel combustion such as residential home heating and wood burning, and industrial processes. Also, natural and miscellaneous sources, such as crustal material from the earth or wildfires, can be sources of particles. Excluding natural and miscellaneous sources, mobile sources are responsible for about 20% of ambient $PM_{2.5}$, although the number can be higher in urban areas. A large fraction of this 20% comes from diesel exhaust.

17. Are there any other constituents of diesel exhaust that are of concern?

Substantial quantifies of nitrogen oxides are emitted in diesel exhaust. Nitrogen oxides contribute to ozone and fine particle formation. Ozone causes numerous adverse health effects (such as increased respiratory symptoms). Nitrogen oxides also adversely affect the respiratory system. EPA established National Ambient Air Quality Standards for ozone and nitrogen dioxide. EPA also established vehicle emission standards for nitrogen oxides for diesels (and gasoline vehicles/engines) to reduce these problems.

18. How do the emissions from diesel engines compare to those from gasoline engines?

It is difficult to directly compare emissions from gasoline and diesel engines since the composition of the particulate matter and exhaust organic gases have some qualitative similarities and quantitative differences. While EPA has issued regulations to control hydrocarbons, carbon monoxide, and nitrogen oxides from gasoline vehicles, there has been little regulation of gasoline particulate matter. Gasoline particulate matter generally is much lower than diesel particulate matter on a gram per mile basis. Furthermore, as other emissions from gasoline engines are controlled, particulate emissions have also been decreasing. Still, limited bioassay and animal test results suggest that gasoline particulate may also be carcinogenic. EPA is studying this issue.

19. What can communities do to reduce exposure to diesel exhaust?

There are a number of options for local communities. Because EPA's regulations for diesel trucks and buses apply only to newly produced engines which phase into the vehicle fleet over time, EPA created the Voluntary Diesel Retrofit Program to reduce emissions now. Emissions from diesel trucks, buses, and construction equipment can be reduced by retrofitting them with engine upgrades, additional pollution control equipment, or engine conversions to burn cleaner fuel. Fleet owners/operators and state/local governments can participate in this program. Information about diesel retrofit programs, including communities currently participating, can be found at www.epa.gov/otaq/retrofit.

In addition, when local governments make transportation planning decisions, they can consider ways to reduce exposure to diesel exhaust. For example, when purchasing new buses local governments can consider a range of lower-emitting options, including alternative-fueled buses and low-emission diesel engines. Also, communities can consider how to reduce exposure to diesel exhaust when deciding where to locate new bus terminals, transfer stations, truck stops, and other such facilities.

Finally, communities can consider options to reduce the idling of trucks and buses. Some areas have adopted anti-idling ordinances. There are also technological options, such as electrification and auxiliary power units on trucks.

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