U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF MOBILE SOURCES

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Air Toxics from Motor Vehicles

What are Air Toxics?

Air toxics are air pollutants that cause adverse health effects. The U.S. Environmental Protection Agency (EPA) has focused most of its air toxics efforts to date on carcinogens, which are compounds that cause cancer. Non-cancer health effects such as reproductive and neurological problems are also of concern to EPA.

How dangerous are air toxics? It's hard to say. Some air toxics have been proven to cause cancer in humans. However, most air toxics are identified through laboratory experiments in which animals receive very high doses of the compound being studied. People almost never breathe such high doses. But lower exposures may still pose risks. One fact is clear: vehicles are such an integral part of our society that virtually everyone is exposed to their emissions.

Air Toxics from Vehicles and Their Fuels

Motor vehicles emit several pollutants that EPA classifies as known or probable human carcinogens. Benzene, for instance, is a known human carcinogen, while formaldehyde, acetaldehyde, 1,3-butadiene and diesel particulate matter are probable human carcinogens. Studies are underway to determine whether other toxic substances are present in mobile source emissions. For example, EPA and industry are investigating whether oxygen-containing fuel additives such as methyl tertiary butyl ether (MTBE) cause any adverse health effects. EPA is also working with the vehicle and fuel industries to test motor vehicle emissions for the presence of dioxin.

EPA estimates that mobile (car, truck, and bus) sources of air toxics account for as much as half of all cancers attributed to outdoor sources of air toxics. This estimate is not based on actual cancer cases, but on models that predict the maximum number of cancers that could be expected from current levels of exposure to mobile source emissions. The models consider available health studies, air quality data, and other information about the types of vehicles and fuels currently in use. Nonroad mobile sources (such as tractors and snowmobiles) emit air toxics as well.

How are Air Toxics from Motor Vehicles Formed?

Some toxic compounds are present in gasoline and are emitted to the air when gasoline evaporates or passes through the engine as unburned fuel. Benzene, for example, is a component of gasoline. Cars emit small quantities of benzene in unburned fuel, or as vapor when gasoline evaporates.

A significant amount of automotive benzene comes from the incomplete combustion of compounds in gasoline such as toluene and xylene that are chemically very similar to benzene. Like benzene itself, these compounds occur naturally in petroleum and become more concentrated when petroleum is refined to produce high octane gasoline.

Formaldehyde, acetaldehyde, diesel particulate matter, and 1,3-butadiene are not present in fuel but are by-products of incomplete combustion. Formaldehyde and acetaldehyde are also formed through a secondary process when other mobile source pollutants undergo chemical reactions in the atmosphere.

Reducing Air Toxics from Motor Vehicles

The emissions that come out of a vehicle depend greatly on the fuel that goes into it. Consequently, programs to control air toxics pollution have centered around changing fuel composition as well as around improving vehicle technology or performance. One of the first, and most successful programs has been the removal of lead from gasoline. The lead phaseout began in the mid-1970s. It will be complete January 1, 1996 when lead is banned from gasoline. The removal of lead from gasoline has essentially eliminated mobile source emissions of this highly toxic substance.

More recent fuel and emission control system changes include:

- **Limits on gasoline volatility**
  Volatility is a measure of how easily a liquid evaporates. As described earlier, some toxics such as benzene are present in gasoline and get into the air when gasoline evaporates. Limits on gasoline volatility have been imposed over the last several years to control evaporative emissions of both hydrocarbon and toxic compounds (most air toxics are hydrocarbons so programs designed to reduce hydrocarbon emissions also reduce air toxics).

- **Reformulated gasoline**
  The 1990 Clean Air Act requires reformulated gasoline to be introduced in the nation's most polluted cities beginning in 1995. From 1995-1999, these gasolines must provide a minimum 15% reduction in air toxics emissions over typical 1990 gasolines. This increases to a 20% minimum reduction beginning in the year 2000. The air toxics reductions will be achieved mainly by reducing gasoline volatility and by reducing the benzene content of the gasoline.

- **Limits on diesel sulfur**
  Regulations limiting the amount of sulfur in diesel fuel took effect in 1993. Today's lower-sulfur diesel fuels are important in reducing emissions of particulate matter and other air toxics from diesel-fueled buses and trucks.

- **More stringent standards and test procedures**
  To date, there are no specific standards for air toxics emissions from motor vehicles. However, the 1990 Clean Air Act does set specific emission standards for hydrocarbons and for diesel particulate matter. Air toxics are present in both of these pollutant categories. As vehicle manufacturers develop technologies to comply with the hydrocarbon and/or particulate standards (e.g., more efficient catalytic converters), air toxics are reduced as well. Requirements under the Act for testing carbon monoxide emissions at cold temperatures will also have an indirect but important effect in reducing air toxics emissions in the critical first moments of vehicle operation.

- **Control of emissions in actual customer use**
  From a pollution perspective, what matters most is not new vehicle emission standards but actual emissions from vehicles on the road. The Clean Air Act establishes several programs to make sure vehicle emission controls are functioning properly in actual use. These include requirements for periodic emission inspections and for computerized diagnostic systems that alert drivers and mechanics to malfunctioning emission controls.

In summary, the many vehicle and fuel changes in the last 25 years have greatly reduced air toxics emissions from highway vehicles. New cars today are capable of emitting 90% less air toxics on a per-mile basis than the

uncontrolled models of 1970; new trucks and buses are designed to emit less than half the air toxics of their 1970 counterparts. Overall air toxics emissions will continue to decrease through the 1990s as older vehicles leave the fleet and as new regulatory programs take effect. However, the number of vehicles on the road and the number of miles they travel is continuing to grow. Without additional controls, growth in vehicle travel will offset progress in reducing air toxics by early in the next century.

What More Can Be Done?

The 1990 Clean Air Act requires EPA to specifically regulate air toxics from motor vehicles in the form of standards for fuels, or vehicles, or both.

Additional hydrocarbon and particulate matter controls such as tightening tailpipe standards even further will reduce air toxics emissions somewhat. California for example, sets tighter hydrocarbon limits for vehicles sold in that state than the federal requirements for vehicles sold elsewhere. Other states can choose to adopt the California standards, which provide some air toxics benefits. Expansion of existing regulatory programs (such as more widespread use of reformulated gasoline or wider requirements for emission inspections) could also help reduce air toxics. Specific vehicle emission standards for one or more toxic compounds are also an option.

Changes in gasoline and diesel fuel composition (such as reducing sulfur, benzene or other aromatic chemical compounds) can also reduce air toxics emissions.

A switch to alternative, non-petroleum fuels that are cleaner than today's gasoline and diesel fuels offers another strategy for reducing air toxics. Choices include alcohols, natural gas, propane, and electricity. These fuels are inherently cleaner than conventional gasoline and diesel because they do not contain toxics such as benzene. In addition, they are made of simpler chemical compounds which yield lower levels of complex combustion by-products such as 1,3-butadiene.

For Further Information

The EPA National Vehicle and Fuel Emissions Laboratory is the national center for research and policy on air pollution from highway and off-highway motor vehicles and equipment. For more information, write us at 2565 Plymouth Road, Ann Arbor, MI 48105; or phone (313) 668-4333.