U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF MOBILE SOURCES

EPA 400-F-92-006

Automobiles and Ozone

What Is Ozone?

Ozone is a form of molecular oxygen that consists of three oxygen atoms linked together. Ozone in the upper atmosphere (the "ozone layer") occurs naturally and protects life on earth by filtering out ultraviolet radiation from the sun. But ozone at ground level is a noxious pollutant. It is the major component of smog and presents this country's most intractable urban air quality problem.

Why Is Ozone a Public Health Problem?

Ozone is a severe irritant. It is responsible for the choking, coughing, and stinging eyes associated with smog. Ozone damages lung tissue, aggravates respiratory disease, and makes people more susceptible to respiratory infections. Children are especially vulnerable to ozone's harmful effects, as are adults with existing disease. But even otherwise healthy individuals may experience impaired health from breathing ozone-polluted air.

Elevated ozone levels also inhibit plant growth and can cause widespread damage to crops and forests.

Unhealthy ozone levels are a problem across the United States, with nearly 100 cities exceeding the U.S. Environmental Protection Agency (EPA) National Ambient Air Quality Standard. The standard is based on the highest ozone exposure sensitive persons can tolerate. Nine cities, home to 57 million people, are considered "severely" polluted, experiencing peak ozone levels that exceed the standard by 50% or more.

How Is Ozone Formed?

Ozone is not emitted directly but is formed in the atmosphere through a complex set of chemical reactions involving hydrocarbons, oxides of nitrogen, and sunlight. The rate at which the reactions proceed is related to both temperature and intensity of the sunlight. Because of this, problematic ozone levels occur most frequently on hot summer afternoons.

Hydrocarbons and nitrogen oxides come from a great variety of industrial and combustion processes. In typical urban areas, at least half of those pollutants come from cars, buses, trucks, and off-highway mobile sources such as construction vehicles and boats.

What's Been Done to Control Ozone Levels?

The Clean Air Act of 1970 gives primary responsibility to state and local governments for regulating pollution from power plants, factories, and other "stationary sources." EPA has primary responsibility for regulating "mobile sources," which include cars, trucks, buses, and aircraft.

The EPA vehicle emission control program has achieved considerable success in reducing both nitrogen oxide and hydrocarbon emissions. Cars coming off today's production lines typically emit 70% less nitrogen oxides and 80% to 90% less hydrocarbons over their lifetimes than their uncontrolled counterparts of the 1960s. The improvement came about in response to stringent regulations, which required auto manufacturers to develop systems capable of capturing excess gasoline vapors and cleansing tailpipe emissions.

Why Aren't Ozone Levels Dropping?

Ozone levels in many cities have come down with the introduction of lower volatility gasoline and as newer cars with improved emission control systems replaced older models. But although there has been significant progress since 1970 in reducing emissions per mile traveled, the number of cars on the road -- and the miles they travel almost doubled in the same time frame.

A second reason that ozone levels remain high is that emission control systems do not always perform as designed over the full useful life of the vehicle. Routine aging and deterioration, poor state of tune, and emission control tampering can all increase vehicle emissions. In fact, a major portion of ozone-forming hydrocarbons can be attributed to a relatively small number of "super-dirty" cars whose emission control systems are not working properly.

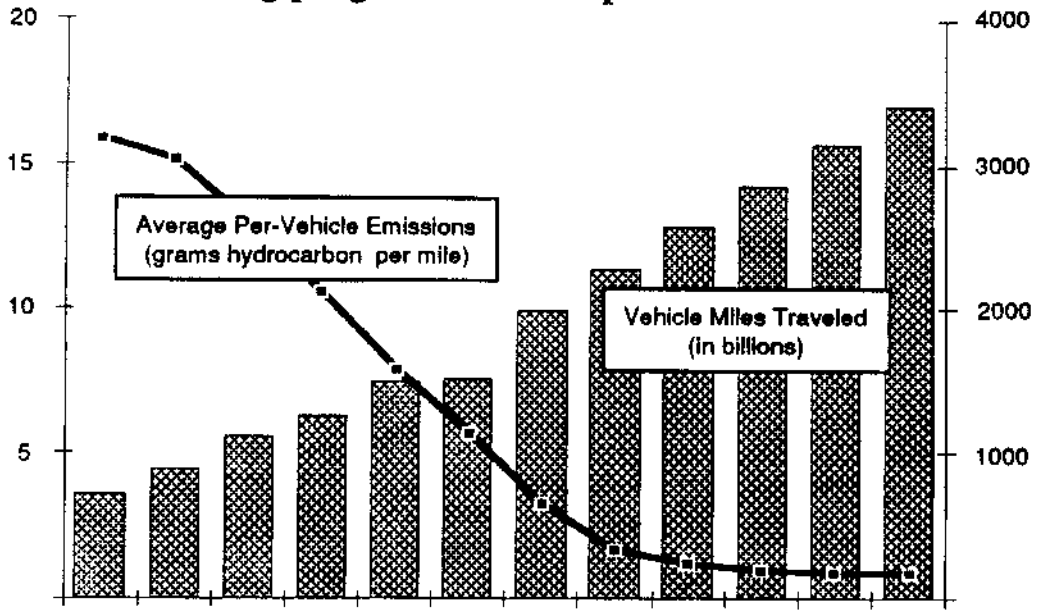
Unless we dramatically reduce the amount of pollution vehicles emit in actual use, or drastically cut back on the amount we drive, smog-free air will continue to elude many cities.

Promising Solutions

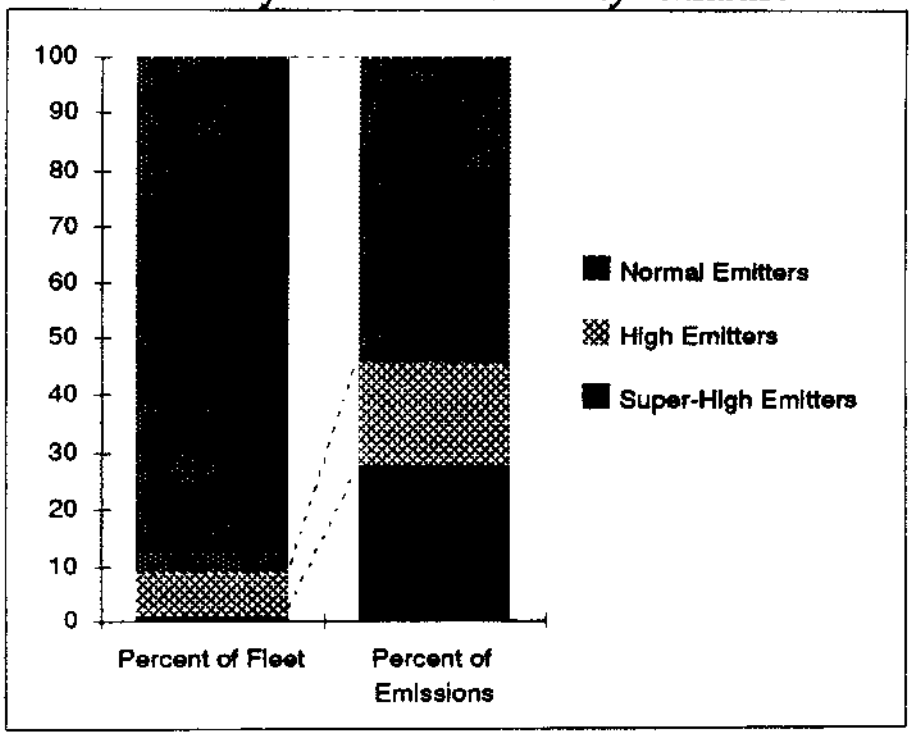
EPA believes that control of hydrocarbon and nitrogen oxide emissions is the most promising strategy for reducing ozone levels in most urban areas. Toward that end, the federal government will establish more stringent limits on gasoline volatility, control hydrocarbon vapors that evaporate during vehicle refueling, tighten tailpipe emission standards, and require improvements in Inspection and Maintenance programs. EPA also is developing requirements for "warning systems" on all cars to alert drivers when the emission controls malfunction.

In the most polluted cities, however, these measures will not be sufficient. The only way to ensure healthy air is to markedly reduce our use of cars or to switch to fuels that are inherently cleaner than conventional gasoline.

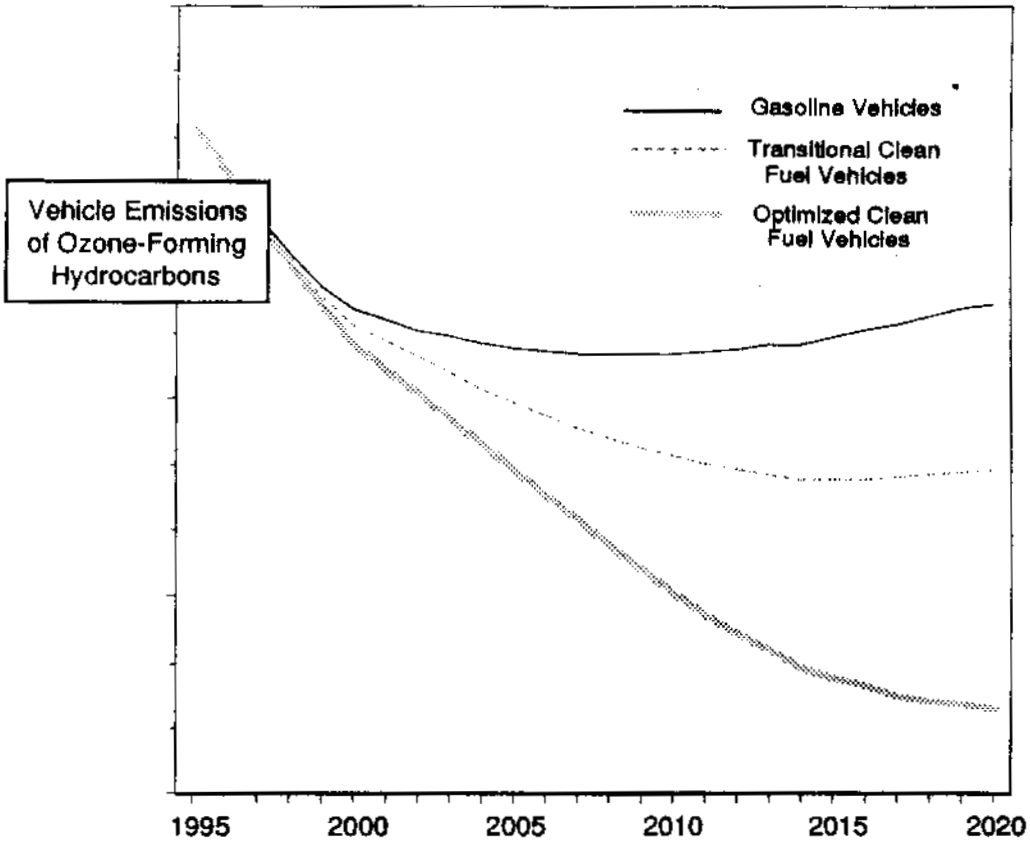
Cars are getting cleaner, but people are driving more, offsetting progress in ozone pollution control



A large amount of hydrocarbon pollution comes from relatively few cars with "dirty" exhaust



Clean-Fueled Vehicles and Potential Ozone Reductions in a Typical City



* Assumes 9 psi gasoline and vehicles equipped with advanced pollution control systems

This chart shows the projected effect of substituting methanol, ethanol, or natural gas fuel for conventional gasoline in a typical large city. Use of electricity would result in somewhat greater reductions in ozone-forming hydrocarbons; propane in somewhat smaller reductions; and reformulated gasoline in considerably smaller reductions, relative to methanol, ethanol, or natural gas fuel.

Because of continued growth in the number of vehicles and miles traveled, hydrocarbon emissions from conventional gasoline vehicles will begin to increase after 2005, despite continued improvements in emission control systems.

If “transitional” vehicles (capable of running on a cleaner fuel, or gasoline) are phased in beginning in 1995, ultimately dominating the fleet by 2020, ozone-forming hydrocarbons will remain relatively constant. But if an aggressive clean fuels program is adopted, overall hydrocarbon emissions will continue to decline dramatically. Such a program would entail a more rapid phase-in of transitional vehicles starting in 1995, followed by the introduction of “optimized” vehicles (designed specifically for optimal performance on one clean fuel) beginning in 2000.

Possible Clean Fuels

Some fuels are inherently cleaner than gasoline because they emit less nitrogen oxides or hydrocarbons, and because the hydrocarbons they do emit are less likely to react in the atmosphere to form ozone. These fuels include:

- **ALCOHOLS:** Methanol (made from natural gas, coal, or biomass) and ethanol (made from grains or sugar) are high-octane liquid fuels. Cars designed to run on pure alcohol fuels have the potential to emit 80% to 90% less reactive hydrocarbons than advanced-technology gasoline cars.

- **ELECTRICITY:** Battery-powered cars have the potential for zero tailpipe and evaporative hydrocarbon and nitrogen oxide emissions, though power plant emissions must be accounted for. Today's electric vehicle technology is limited, but promising recent developments may lead to more widespread use in the future.

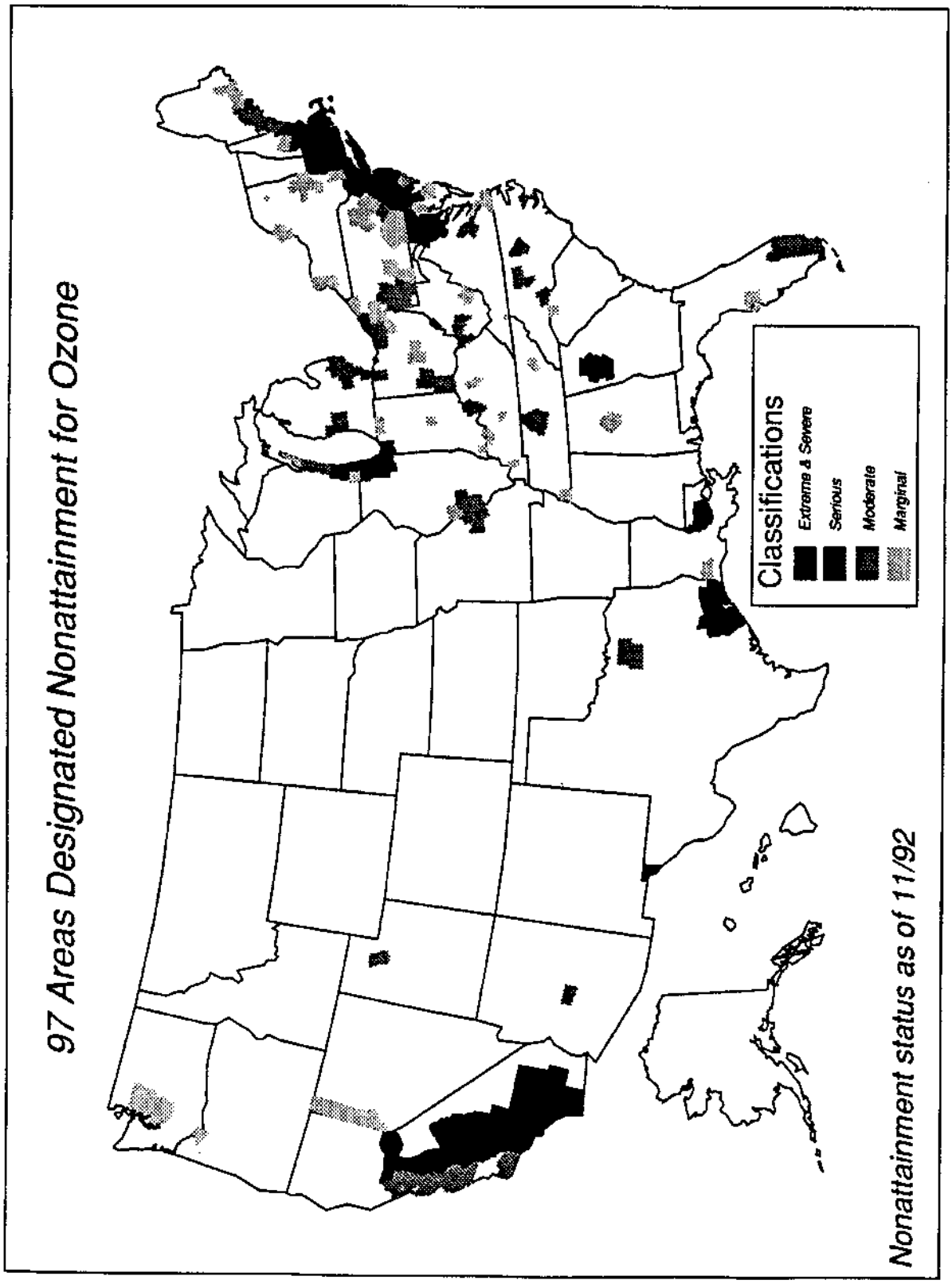
- **NATURAL GAS:** Compressed natural gas is also an excellent automotive fuel, particularly for fleet vehicles where long driving range is not important. Natural gas vehicles have the potential to emit 85% to 95% less reactive hydrocarbons than advanced-technology gasoline vehicles.

- **LIQUID PETROLEUM GAS (PROPANE):** Propane is a byproduct of petroleum refining and natural gas production. Propane vehicles emit considerably less ozone-forming hydrocarbons than do vehicles fueled with conventional gasoline.

- **REFORMULATED GASOLINE:** The petroleum industry is studying ways to change refinery procedures to make a cleaner-burning gasoline. A number of "clean" gasolines have recently been introduced into the marketplace, and research is continuing to develop even cleaner fuels. Reformulated gasoline, capable of reducing hydrocarbon emissions by at least 15%, will be required in some high ozone areas beginning in 1995.

For Further information:

The EPA National Vehicle and Fuel Emissions Laboratory is the national center for research and policy related to auto pollution. To reguest fact sheets on other mobile source issues, write to us at 2565 Plymouth Road, Ann Arbor Ml 48105, or call 313/ 668-4333.


97 Areas Designated Nonattainment for Ozone
Classifications
Extreme & Severe
Serious
Moderate
Marginal
Nonattainment status as of 11/92