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Environmental Protection
Agency

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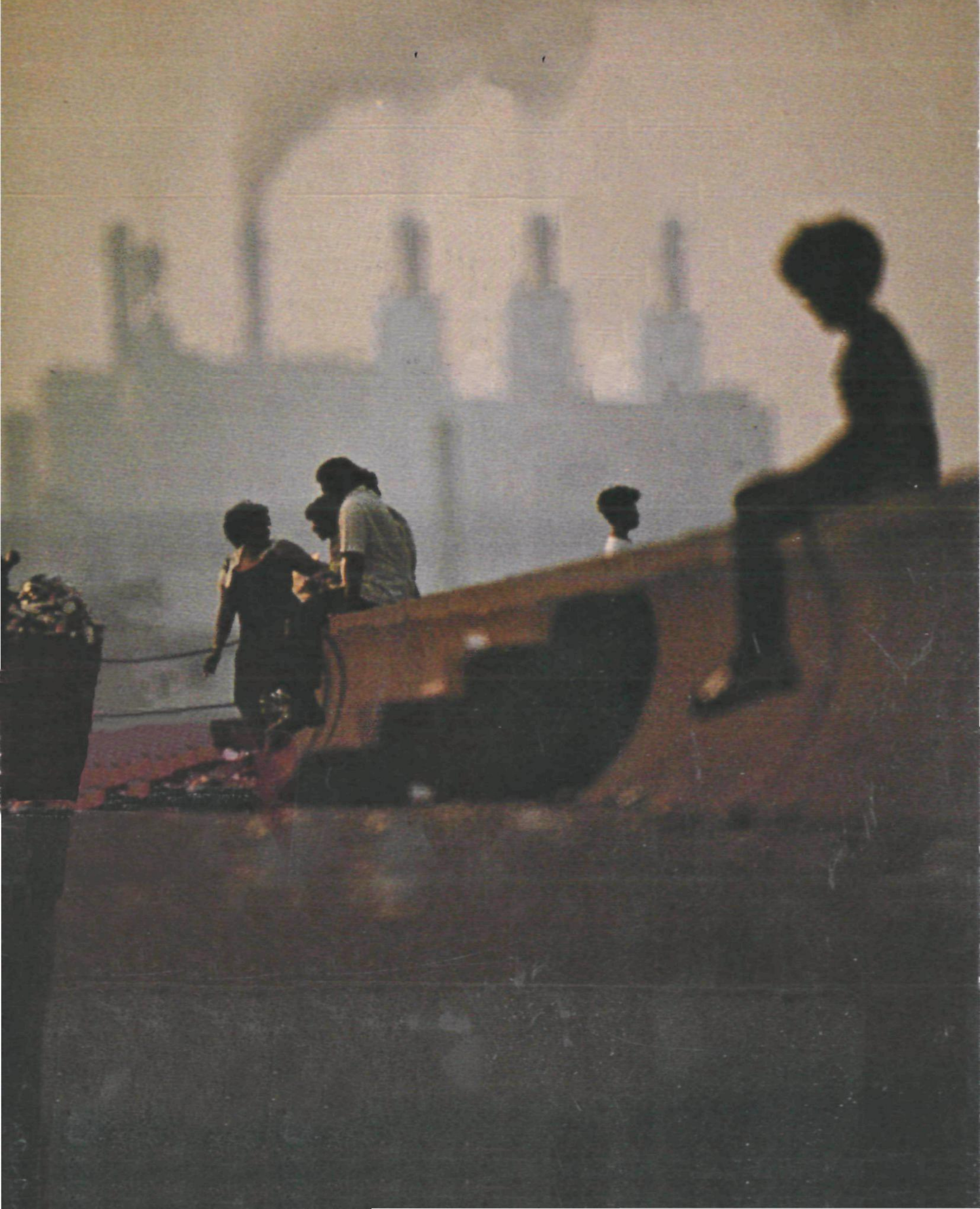
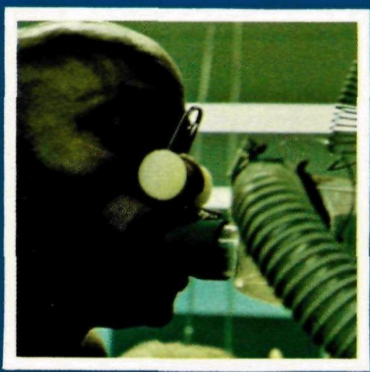
EPA

Air Pollution and Your Health





The air you breathe can sometimes make you sick, even kill you.

People have known for centuries that air could carry poisons. Metal workers succumbed to smelter fumes. Hatmakers often became irrational from breathing the mercury they used in making felt (hence the phrase "mad as a hatter"). Miners took caged birds into the coal pits; if the birds died the men knew the air contained deadly gases they could not smell.

These are examples of bad air in a particular workplace or occupation. The general poisoning of the ambient, or surrounding, air did not occur until after the industrial revolution, when concentrations of factories and chimneys began pouring vast quantities of smoke, soot, and combustion gases into the air of certain cities. When windless, stagnant weather allowed these pollutants to accumulate in one area for several days in succession, the damage could be disastrous, with thousands of persons made sick and scores or even hundreds of deaths.

Such acute episodes of air pollution were at first blamed on "smog," a word coined from smoke and fog. We now know that fog — visible water vapor — had little to do with widespread sickness. Fog just coincided with the weather conditions that trapped the pollution from smokestacks and chimneys.

In recent years most air pollution episodes have been associated with automobiles as well as industry. Smog has come to mean the thick haze that often blankets big cities and is clearly visible from a distance. This smog is made up mainly of photochemical oxidants, a kind of pollution that is formed in air from auto exhausts and industrial emissions by chemical reactions spurred by sunlight. Acute cases of this kind of smog have occurred in urban areas throughout the country — Los Angeles, Denver, Chicago, Birmingham, Pittsburgh, New York, and St. Louis — where both autos and industry are concentrated. Episodes can also occur in areas like Washington, D.C.; St. Petersburg, Fla.; and Phoenix, Ariz.; where there is little industry and autos are mainly responsible for the pollution.

If a Lot Can Hurt, a Little Won't Help

If high levels of air pollution can cause marked increases in sickness and deaths, it is reasonable to think that lower, less acute pollution can also be harmful to health. Thousands of scientific and medical studies in recent years have shown positive relations between air pollution and increases in respiratory ailments, heart disease, and cancer. Just what role pollutants play in making people sick is not yet fully understood; no single disease but a mixture of ailments is involved, and pollutants usually occur in varying combinations, rather than one at a time.

The human body is a complicated organism. Individuals vary widely in their reactions to bodily stress. They also vary widely in occupations and habits that help determine the amounts of pollution they are exposed to. Many people breathe extra pollution at their jobs, and many breathe the polluting smoke of cigarettes, their own or others'.

Despite these handicaps, scientists have established that air pollution does harm human health. They have done this by means of three kinds of studies:

Epidemiological research. This compares pollution levels with health statistics: hospital admissions, the number and severity of illnesses, and death rates. Many strong correlations have been found, that is, effects increase when pollution increases, decrease when pollution levels go down.

Animal experiments. In the laboratory, controlled amounts of air pollution have been found to harm monkeys, dogs, rats, and other experimental animals. There is a strong presumption that whatever make rats and monkeys sick will do the same for people.

Human experiments. Studies with human volunteers also show adverse effects from breathing polluted air in controlled situations, as in the U.S. Environmental Protection Agency's Health Effects Research Laboratory in North Carolina. However, such tests are comparatively rare and are usually limited to young, healthy subjects and to exposures involving no risks known to be serious.

Clinical experience with persons accidentally exposed to high levels of air pollution has added a lot to our knowledge of pollution's health effects, but such cases are not, strictly speaking, scientific experiments.

Who Gets Sick and How

The gist of the scientific studies and the clinical evidence can be summed up briefly. Air pollution is related to human sickness and sometimes to premature death. People of both sexes and all ages can be affected, but the danger is greatest for the very old and the very young and people already sick with certain chronic ailments.

Air pollution probably causes and certainly aggravates:

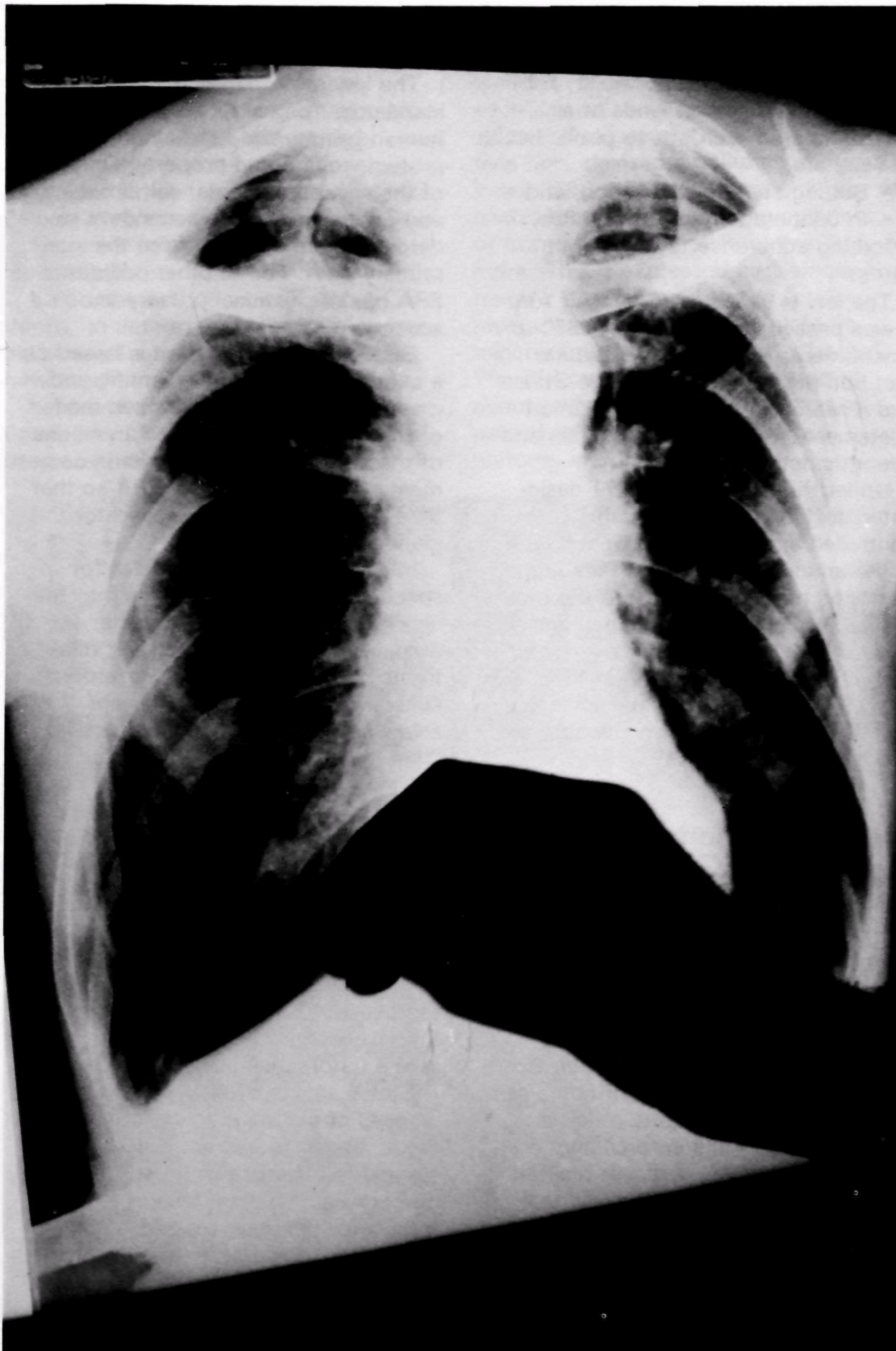
- Disease of the respiratory (breathing) system: nose, sinuses, throat, bronchial tubes, and lungs. All these organs have direct contact with breathed-in air.
- Diseases of the heart and blood vessels. Pollutants can pass through the lung membranes into the blood.
- Cancer, especially of the lungs. Airborne cancer-causing agents can enter the body through the skin as well as the lungs and be carried by the blood to any organ.
- Skin diseases, allergies, eye irritation.

No one is free from air pollutants. Since we all must breathe the ambient air, everyone is exposed to some degree. Those who live in or near big cities are likely to have more exposure, because heavy automobile traffic and polluting industrial plants tend to be concentrated in these areas. Those who can least afford to move away from urban areas to avoid dirty air are the urban poor and old people living on fixed incomes.

But pollution can affect the middle classes and the well-to-do as well as the poor, the young and healthy as well as the old and sick, residents of suburbs and rural areas as well as cities.

Large masses of polluted air can drift with prevailing winds from the cities where they were formed to cause discomfort and health risks to people far away. Connecticut is frequently polluted by air drifting from New York City and northern New Jersey. Los Angeles smog regularly moves eastward to affect people in Riverside, 50 miles away, and to damage trees in the San Bernardino Mountains. EPA scientists have traced "plumes" of air pollution from St. Louis that are still intact and measurable 100 miles away over southern Illinois.

Controlling or reducing air pollution is obviously a problem that cannot be solved by State or local action alone. Pollution is no respecter of political boundaries.



Chest X-ray shows how lung damaged by emphysema is much larger than normal lung

What Is Being Done?

By Federal law, Congress has charged the U.S. Environmental Protection Agency (EPA) with responsibility for:

- Determining what kinds of air pollutants are hazardous to public health and welfare,
- Setting standards for each, and
- In cooperation with the States, enforcing adherence to these standards.

The law is called the Clean Air Act. It was passed by Congress in 1970 as amendments to previous legislation that had provided assistance to States and research funding in air pollution abatement. It was amended again and strengthened in 1977.

Under the law, EPA in 1971 designated six kinds of air pollutants to be controlled and set limits for each type in the ambient air. The six were judged to be the most pervasive and the most in need of immediate reduction and control. A seventh standard — for airborne lead — was adopted in 1978. All of them, with their principal sources and their effects on human health, are described in the final section of this pamphlet, starting on page 7.

The law provides for two kinds of standards: "primary," to protect human health, and "secondary," to protect welfare and property. Only two of the seven pollutants, sulfur oxides and particulates, have secondary standards that are different from the primary ones. For all other pollutants EPA has set identical primary and secondary standards.

Each air quality standard is based on a careful survey of the scientific and medical studies that have been made of that pollutant's effects. Summaries of these surveys, called "criteria documents," are published by EPA so that the public may know the basis for the standard.

In addition, the law provides for special curbs on the emission into the air of hazardous substances that are associated with disease risks at relatively low concentrations. Hazardous substances designated so far are asbestos, mercury, beryllium, vinyl chloride, and benzene.

The 1977 Amendments to the Clean Air Act

The 1970 Act set as a goal the general attainment of the health-protecting primary standards by July 1975. That date came and went without the goal being universally reached. At many monitoring sites the standards were being exceeded with considerable regularity, though less often than they had in the past. This did not come as a surprise to EPA and State officials. Soon after the Act's enforcement efforts got under way, officials realized that it was not possible to meet the Act's goal in every area that soon.

In the Clean Air Act Amendments of 1977 Congress set new deadlines: as expeditiously as possible but not later than 1982, for general attainment of the primary standards. This provided a more realistic target.

A further extension of the deadline, to 1987, was provided for two pollutants most closely related to transportation systems, carbon monoxide and ozone (photochemical oxidants).

States are required to inventory all sources of air pollution in "nonattainment" areas, those that exceed the standards. And States must draft and carry out abatement plans in a more methodical manner, making full use of past experience and the management methods that have proved to be effective.

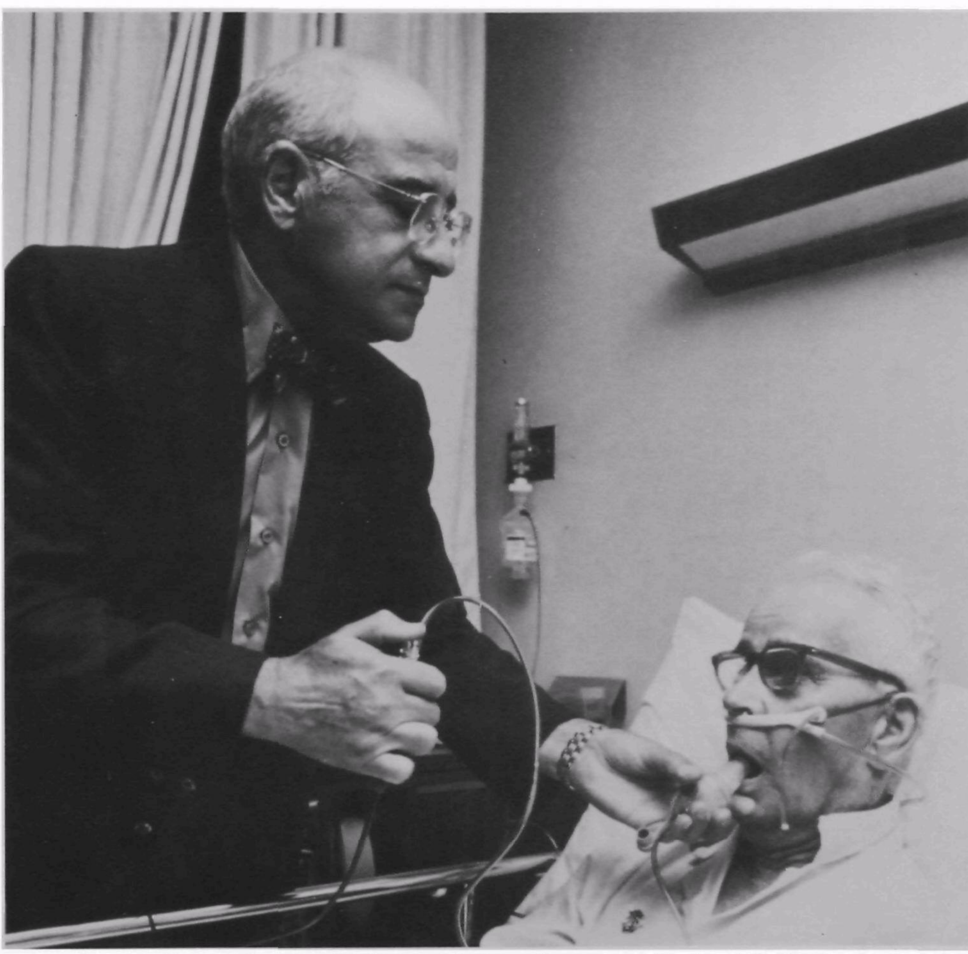
Keeping Track of Air Pollution

A nationwide network of monitoring stations, established by EPA and the States, measures pollution levels regularly and feeds the information to official centers for tabulation and analysis. Under certain conditions, readings may be taken several times a day, or even hourly.

There are two purposes for such reporting:

- For research on air pollution trends, to determine if we are reducing pollution of a certain kind, and if so how much.
- To warn people whenever pollution in any locality is reaching dangerous levels.

It is now common practice to include air pollution conditions in the weather reports given several times each day on radio and television broadcasts and in newspapers. EPA scientists have devised a pollution standards index (PSI) that indicates the degree of health hazard from any one pollutant or from any combination of two or more. This is expressed by a single number that is keyed to the actions recommended for people to take to minimize their exposure to the hazard. The PSI rating has been adopted by about half the States and is soon expected to become a nationwide, uniform, warning system.



Physician attends a patient hospitalized with lung disease ascribed to inhaling iron mine dust

Summing Up

The adverse health effects of air pollution are widespread and costly even though they cannot be measured precisely and recorded in a ledger. Sickness means increased costs for medical care, hospitalization, and drugs. Time lost by wage earners is a debit to the persons involved and to the national economy. Dollar values can be estimated for the loss of clean air's amenities, unobscured views, more enjoyable surroundings.

All these costs add up to a substantial, though imprecise, sum. The American Lung Association, after surveying 23 studies made in a ten-year period by government, industry, and university scientists and economists, concluded that a reasonable estimate of the health cost of polluted air in the United States is more than $10 billion per year.

The air quality standards are still being exceeded in many parts of the country, but the number of violations is steadily going down. There is still a long way to go before we succeed, but improvements are already apparent. This is due to emission controls on autos, stack gas controls and process improvements by industry, and an increased awareness by everyone that people have a right to breathe clean air.

Cities bring polluting vehicles and people together; this is mid-town Manhattan

Principal Kinds of Air Pollution, Their Sources and Effects

Here are brief descriptions of the air pollutants for which EPA standards have been set, their principal sources, and summaries of the adverse effects of each on human health.

Sulfur oxides are gases that come from the burning of sulfur-containing fuel, mainly coal and oil, and also from the smelting of metals and from certain industrial processes. They have a distinctive odor. Sulfur dioxide (SO_2) comprises about 95 percent of these gases, so scientists use a test for SO_2 alone as a measure of all sulfur oxides.

As the level of sulfur oxides in air increases, there is an obstruction of breathing, a choking effect that doctors call "pulmonary flow resistance." The amount of breathing obstruction has a direct relation to the amount of sulfur compounds in the air. The effect of sulfur pollution is enhanced by the presence of other pollutants, especially particulates and oxidants. That is, the harm from two or more pollutants is more than additive. Each augments the other, and the combined effect is greater than the sum of the parts would be.

Many types of respiratory disease are associated with sulfur oxides: coughs and colds, asthma, bronchitis, and emphysema. Some researchers believe that the harm is mainly due not to the sulfur oxide gases but to other sulfur compounds that accompany the oxides: sulfur acids and sulfate salts.

Particulates are solid particles or liquid droplets small enough to remain suspended in air. They include dust, soot, and smoke — particles that may be irritating but are usually not poisonous — and bits of solid or liquid substances that may be highly toxic.

Particulates are measured all together by filtering all the particles from a known amount of air and weighing them. The EPA standard for particulates gives only a rough indication of the health hazard, since it does not separate toxic particles from those that are merely annoying. Research is under way to find quick, economical methods of measuring various kinds of particles and also their sizes. The smaller the particles, the more likely they are to reach the innermost parts of the lungs and work their damage.

The harm may be physical: clogging the lung sacs, as in anthracosis, or coal miners' "black lung" from inhaling coal dust; asbestosis or silicosis in people exposed to asbestos fibers or dusts from silicate rocks; and byssinosis, or textile workers' "brown lung" from inhaling cotton fibers.

The harm may also be chemical: changes in the human body caused by chemical reactions with pollution particles that pass through the lung membranes to poison the blood or be carried by the blood to other organs. This can happen with inhaled lead, cadmium, beryllium, and other metals, and with certain complex organic compounds that can cause cancer.

Many studies indicate that particulates *and* sulfur oxides (they often occur together) increase the incidence and severity of respiratory disease.

Carbon monoxide (CO) is a colorless, odorless, poison gas formed when carbon-containing fuel is not burned completely. It is by far the most plentiful air pollutant. EPA estimates that more than 102 million metric tons of CO are spewed into the air each year in the United States. (A metric ton is 1,000 kilograms, or about 2,200 pounds.)

Fortunately this deadly gas does not persist in the atmosphere. It is apparently converted by natural processes to harmless carbon dioxide, in ways not yet understood, fast enough to prevent any general buildup. But it can reach dangerous levels in local areas, as in city-street canyons with heavy auto traffic and little wind. More

than 75 percent of the CO emitted comes from road vehicles.

Clinical experience with accidental CO poisoning has shown clearly how it affects the body. When the gas is breathed, CO replaces oxygen in the red blood cells, reducing the amount of oxygen that can reach the body cells and maintain life. Lack of oxygen affects the brain, and the first symptoms are impaired perception and thinking. Reflexes are slowed, judgment weakened, and a person becomes drowsy. An auto driver breathing high levels of CO is more likely to have an accident; an athlete's performance and skill drop suddenly. Lack of oxygen then affects the heart. Death can come from heart failure or general asphyxiation, if a person is exposed to very high levels of CO.

Ozone is a poisonous form of pure oxygen and the principal component of modern smog. Until recently EPA called this type of pollution "photochemical oxidants." The name was changed because ozone was the only oxidant actually measured and by far the most plentiful.

Ozone and other oxidants — including peroxyacetal nitrates (PAN), formaldehydes, and peroxides — are not emitted into the air directly. They are formed by chemical reactions in the air from two other pollutants, hydrocarbons and nitrogen oxides. Energy from sunlight is needed for these chemical reactions, hence the term *photo*chemical smog, and the daily variation in ozone levels, increasing during the day and decreasing at night.

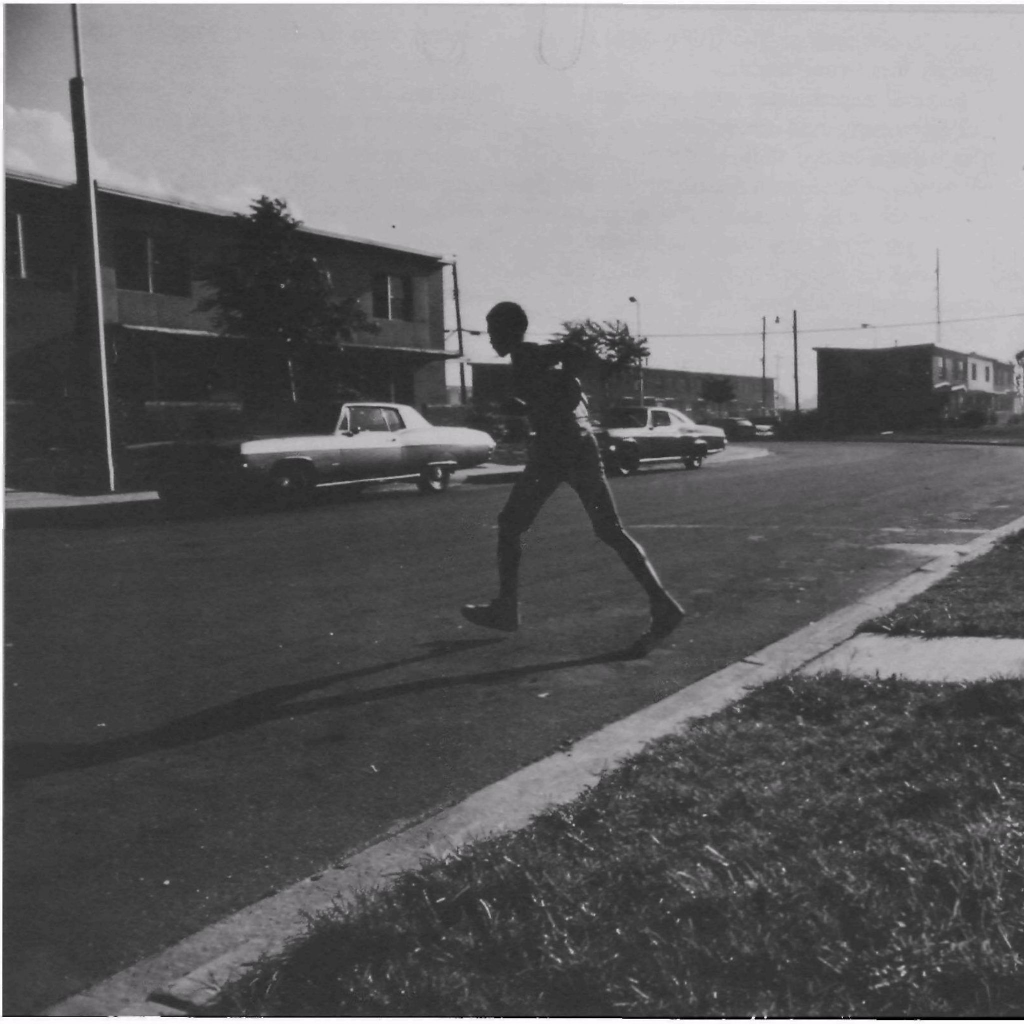
Ozone is a pungent-smelling, faintly bluish gas. It irritates the mucous membranes of the respiratory system, causing coughing, choking, and impaired lung function. It aggravates chronic respiratory diseases like asthma and bronchitis and is believed capable of hastening the death, by pneumonia, of persons in already weakened health. PAN and the other oxidants that accompany ozone are powerful eye irritants.

Steel plant pollution along the Monongohela River spreads over downtown Pittsburgh, Pa.

It is an irony of nature that a form of pure oxygen can be so harmful. Regular oxygen (O_2, two atoms to the molecule) gives life to all animals and most plants; ozone (O_3, three atoms) is poisonous.

Note: Ozone in the air we breathe should not be confused with the so-called "ozone layer" in the stratosphere. The stratosphere begins at an altitude of seven to ten miles, depending on the latitude and the season of the year. Ozone in this thin air absorbs a large part of the sun's ultraviolet radiation. Scientists believe that some human actions — for instance, supersonic aircraft flights and the release of fluorocarbon gases from spray cans — could cause a permanent reduction in stratospheric ozone. This could increase the ultraviolet radiation reaching the earth, raising the incidence of human skin cancer and probably affecting the earth's climate and ecological systems in unpredictable ways. The high ozone layer seems to be maintained by natural processes, mainly the sun's radiation. Lightning discharges are the principal natural source of ozone in the lower atmosphere.

Nitrogen oxides. When any fuel is burned at a high enough temperature — above 650°C (1,200°F) — some of the abundant nitrogen in the air will react too, forming poisonous, highly reactive gases called nitrogen oxides. Nitrogen dioxide (NO_2) is the most plentiful of these and the one measured to indicate all. It is a suffocating, brownish-colored gas and a



strong oxidizing agent, quick to react with water vapor to form corrosive nitric acid.

Principal sources of nitrogen oxide emissions are electric utility and industrial boilers (56%) and auto and truck engines (40%.)

Occupational health studies have shown that nitrogen oxides can be fatal at high concentrations. At lower levels, they can irritate the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections like influenza. However, the principal harm to people seems to come not from nitrogen oxides directly but from the oxidants they help to form by uniting in sunlit air with hydrocarbons to make ozone and other ingredients of photochemical smog.

NO_2 has been difficult to measure in the ambient air. The first sampling and analysis methods turned out to be unreliable and were withdrawn as official methods in 1973. After extensive testing a reliable monitoring technique was approved in 1976.

Children play on street in North Birmingham, Ala., near pollution from industrial plants

Hydrocarbons are unburned fuels in gaseous or vapor form. Gasoline, for example, is a mixture of many kinds of hydrocarbons, each containing more than twice as many hydrogen atoms as carbon atoms linked together in molecules of many different sizes and patterns.

Unlike sulfur and nitrogen oxides, the vast family of hydrocarbons is not measured by testing for a single compound. Indeed, the simplest hydrocarbon, methane (CH_4), that occurs in swamps, coal mines, and natural gas, is excluded by the official testing method; only more complex hydrocarbons that are highly reactive are measured.

Most of the estimated 28 million metric tons of hydrocarbons emitted each year in the United States come from gasoline vapors that escape burning in auto engines, either evaporating from the tank or fuel lines or going out the tail pipe. Other large sources are gasoline stations, handlers, and transporters; industries that use solvents; and users of paint and drycleaning fluids.

At the levels usually found in ambient air, hydrocarbons, as a class of compounds, may have no direct effect on human health. In a confined space, of course, they could cause asphyxiation by displacing the air, and some, like benzene, can be hazardous in themselves. A major problem with hydrocarbons stems from the oxidants they help to form by reacting with nitrogen oxides in sunlight.

Lead. Particles of this metal or its compounds enter the air from auto exhaust (tetraethyl lead, an anti-knock agent in gasoline) and from industries that smelt or process the metal. About 90% of all airborne lead is from autos.

Lead is absorbed into the body and accumulates in bone and soft tissues. Its most pronounced effects are on the blood-forming, nervous, and kidney systems, though it may also affect other body functions. Young children are especially susceptible to lead poisoning.

The ambient air standard for lead was adopted by EPA in 1978, seven years after the other six standards.

If you have suggestions, questions, or requests for further information, they may be directed to your nearest EPA Regional public information office.

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