near grain elevators and from subterranean burning at a dump give most positive results. Studies are also made on a post-episode basis by using available vital statistics to determine increased morbidity and mortality during such situations. It is common to find hundreds of excess deaths as the result of an extended period of high air pollution.

With respect to effects of air pollution on the economy, our research include studies of damage to property, corrosion of metal and masonry structures, vegetation damage, including that occurring in forested areas, and deterioration of electrical contacts, power distribution lines and fabrics.

In engineering and the physical sciences, investigations are conducted in four major scientific areas: engineering, chemistry, physics, and meteorology. Most studies focus principally on the Nation's major air pollution problems: motor vehicle emissions, sulfur oxide pollution, and nitrogen oxides.

With respect to motor vehicle pollution, our research includes continuing efforts to investigate the practicability of various systems for controlling emissions and to develop test procedures for measuring emissions and evaluating the effectiveness of control devices. The national standards for crankcase ventilation and exhaust control systems, which are effective on 1968 model-year gasoline-powered vehicles, are only the beginning of controls in this area. Standards for the control of carbon monoxide and hydrocarbons from gasoline-powered trucks and buses, more restrictive standards for passenger vehicles, and regulations for diesel smoke and odor, fuel tank and carburetor evaporative losses, and control of nitrogen oxides are being investigated.

To help achieve control of the important problem of sulfur oxide pollution from combustion of fossil fuels, research is being pursued on several fronts, including removal of sulfur from coal and residual oil and removal of sulfur oxides from combustion effluents.

Investigations are also under way on the control of other potentially harmful contaminants, such as nitrogen oxides from combustion sources, lead additives from motor fuels, rocket exhausts, incinerator effluents, and other types of combustion and industrial effluents.

The chemistry of polluted atmospheres is still a largely unexplored area for research. Programs are under way to develop sampling and analytical techniques and to standardize them. Research is proceeding also on defining the photochemical processes that occur in the atmosphere, and the effects on these processes of the input mix (e.g., reactivity of the hydrocarbons involved) and of the ratio of the two principal ingredients, hydrocarbons and nitrogen oxides. Effects of irradiation intensity and period of irradiation are also under study. The problem of selective controls on vehicles and their effect on the photochemical process adds another continually changing variable to an already complex problem.

A highly specialized program is the development of techniques by which meteorologists can study air movements over long distances in far greater detail than has been possible to date. These techniques entail the release of harmless compounds, e.g., sulfur hexafluoride and other halogenated gases, followed by periodic collection and analysis by electron-capture gas chromatography. Present work indicates that measurements at concentrations as low as $10^{-6}$ ppm are practicable, and that sensitivity may be increased by several orders of magnitude by using concentration steps prior to analysis.

Research on the physical characteristics of atmospheric pollutants includes studies in a number of areas: 1. The size distribution, form, specific composition, and other detailed characteristics of urban particulates. These data are needed to help evaluate the toxicity of particulates and their role in corrosion, visibility reduction, atmospheric reactions, and potentiation of the effects of irritant gases. 2. The role of surface properties in effects associated with aerosols, which may be elucidated by a study of the thermodynamic and kinetics of gas-particulate systems. 3. The use of recent advances in the physical sciences in developing improved techniques for air pollution measurements, e.g., plume transmittance, remote infrared and laser monitoring, and remote temperature soundings.

Meteorological studies constitute an important part of air pollution research. Meteorologists assigned to the Taft Center in Cincinnati maintain daily surveillance of national weather charts to forecast periods of sluggish air movement over extensive geographic areas—periods that are conducive to accumulation of air pollutants. Research is under way to quantify these forecasts, particularly in terms of the large diurnal variation in air pollution potential, to extend