

sources may be controlled or eliminated. The quality and character of the air environment, the sources of pollutants, and their control are obvious arenas for engineering and physical sciences research.

#### Engineering and Physical Sciences Research

Space does not permit an area-by-area or project-by-project discussion of current research in the engineering and physical sciences. This discussion will be directed to the principal areas under study, focusing on those items that in our opinion are the most pressing for the immediate future. This approach will not allow the discussion to proceed in neatly tied packages representing professional disciplines, but this is the interdisciplinary nature of research in the environmental field, and particularly in air pollution. Engineering and physical sciences research in air pollution requires a multiplicity of talents: organic and inorganic analytical chemists; photochemists, physical chemists, meteorologists; physicists; sanitary, electronic, electrical, chemical, mechanical, and automotive engineers; statisticians, mathematicians, and data-handling specialists. Studies closely associated with these disciplines require others, such as economists, urban planners, sociologists, and information specialists. The field is broad, and the talents of many are needed.

#### Vehicle Emission Research

The most widely publicized area of air pollution research concerns the nature, effects, and control of vehicular emissions. The term "vehicle emissions" is used rather than "automobile exhaust" because it includes all moving transportation sources—both gasoline- and diesel-fueled automobiles, trucks, and buses; and all emissions—tailpipe

exhaust, crankcase ventilation, and evaporative losses. There is also some concern over pollution from aircraft. Although considerable effort has gone into this area of research over the past 10 to 15 years, the results have mainly served to improve our understanding of the complex physical-chemical-engineering systems involved and to delineate areas of fruitful research for the immediate future. Gone is the hope for finding "the" chemical compound in the atmosphere responsible for all effects of California-type smog, from whence we could trace the "culprit" to its source and eliminate it. In lieu of this panacea has come some understanding of the complex nature of the problem of vehicle emission pollution and associated photochemical phenomena. This understanding is vital and points the way toward eventual solution of this particular problem through a series of complicated developments and innovations. The disconcerting aspect of what has been learned is the probability that additional significant photochemical systems, involving pollutants from sources other than the automobile, may be on the horizon.

The outlook for the vehicle emission pollution problem involves three phases: (1) control of vehicle emissions from the types of power plants used today. This will be an interim measure leading to (2) modification of the power plant to so improve its combustion efficiency that it will meet presently sought goals, e.g., the state of California standards: 80 per cent reduction in over-all hydrocarbon emissions and 40 per cent reduction in carbon monoxide emissions. This again will be an interim measure leading to (3) development of new-type power plants with essentially no emissions as we know them today.

The delineation of emissions into chemical species indicates a potpourri of organics, most of which are hydrocarbons, although this does not insure by