

mated at \$2.5 billion for 1965 with \$10 million of that earmarked for pollution equipment. The continued growth of the organic chemical industry and its capital spending outlay would seem to indicate its ability to afford air pollution control equipment. The rapid, continuing changes which occur in the number and kind of products made and the methods used for making products imposes particularly great needs for continual attention to means for minimizing pollutant emissions in this industry group.

THE SYSTEMS APPROACH TO CONTROL

In concluding my review of the technical adequacy of current air pollution control measures, Mr. Chairman, I would like to discuss briefly the air resource management or systems approach to air pollution control. This ideal approach to control is through a regional or what has been termed an "air shed" program, with the air shed encompassing all pollution sources in an area and all communities exposed to the air polluted by these sources. The control program for a particular air shed is developed rationally. Standards of air quality are selected; from this baseline and from data on the natural characteristics of the area, standards for emissions from different sources are calculated; and on the basis of these emission limitations construction and process codes are developed.

This approach is attractive and apparently simple. However, certain fundamental problems must be solved before the approach can be fully implemented.

The first of these is social. Air quality standards, if they are to be broadly applied, have to be acceptable not only to the scientists who must devise the means of achieving them, but must be acceptable to the public, who in the long run must pay for the benefits derived from their application. I do not believe, Mr. Chairman, that there is any question in anyone's mind but that air quality standards should be vigorous enough to prevent adverse health effects in even the most sensitive of the human population. I believe that most of us would also want standards sufficiently vigorous to prevent sensory irritation, injury to animals, and damage to ornamental plants or agricultural crops. However, while it has been amply demonstrated that air pollution at levels routinely found in community atmospheres is associated with these adverse effects on health and welfare, there is a vast amount of research that must be conducted before we reach, if we ever reach, a perfect understanding of the cause and effect relationships between air pollution and the damage we now observe.

Let me at this point, Mr. Chairman, identify some of the more important areas in which we need to expand our knowledge of the effects of air pollution. I will limit myself to the effects of air pollution on health.

A principal objective for research both now and in the future is to establish the cause-and-effect relationship between known dosages of air pollutants, singly or in combination, and the health or welfare of man under known environmental conditions. This will require the acquisition of new information at all levels, from basic research to field investigation.

The basic mechanisms of action of many agents are ill-defined or unknown, and we must understand these if we are to define capacities for physiologic and toxicologic actions. Eye irritation, for example, is one common response not so defined.

Major attention has been given the respiratory system. Direct or indirect effects upon other functional systems and tissues may assume greater importance under proper circumstances. The results of exposing animals to irradiated auto exhaust indicate that exposed parents have fewer offspring and that infant mortality is high in these offspring. This apparent effect upon reproduction should be clarified. Other promising areas for investigation would include blood chemistry and cells, the liver, the kidney, and the circulatory system.

Knowledge of the potentiation or synergism of mixtures of air pollution agents, or of agents plus other environmental conditions or agents, will probably be more valuable to control efforts than the most intimate knowledge of a single agent. Mixtures of gases and particles require intensive, well-designed study. More adequate knowledge of the joint effects of agents and infectious disease is critically important concerning not only the acute infection but also the pathogenesis of chronic debilitating conditions, ventilatory diseases such as emphysema, and cancer of the lungs.

The immuno-chemistry of air pollutants has not been explored to a useful extent. The antigenic capacity of organic particulate matter in the air is of both