development stage, and eventually into engineering application, does not lend itself well to predetermined standards. For most engineering developments, the Bureau of Mines tends to stop short of the application stage. Once our research effort has advanced to a showing of feasibility and our results are made available to the public through discussion and publication, our role becomes one of encouraging application by the private sector. At times, completion of the development work calls for close cooperation between the Bureau and industry by formal agreement. The public interest is always protected in arrangements of this type as the Bureau retains all publication and patent rights from such joint studies. It should be noted, however, that there may be certain important research and development areas where there is little or no incentive for the private sector to become engaged. If investigatory studies in these areas are in the national interest, as for example acid mind drainage from abandoned mines, Government has no choice other than to explore these fields to the extent needed and in the required depth.

The question raised in the report with respect to a tendency to fragment research as to source or environment sector is particularly interesting. A good example of a piecemeal approach would be the use of aqueous scrubbing of flue gas to remove the sulfur oxides. This method might provide a satisfactory solution for the cleaning of the stack effluent of sulfur dioxide, but the disposal of the acid formed might merely create a stream pollution problem to replace the atmospheric one. We are fully aware of the management problem that is involved here, and therefore are again looking to the systems approach to aid us.

PRESENT STATE OF POLLUTION ABATEMENT TECHNOLOGY

In addition to the views I have just expressed on the broader aspects of the problem, I believe your committee would be interested in our evaluation of the present status of scientific information and engineering technology, as it applies to air pollution abatement and the future needs in this field if an improved environment is to be attained. As I indicated before, scientific information on pollution abatement is for the most part more advanced than is the engineering technology. There *are* theoretically sound ways to prevent the formation of many environmental pollutants, or ways of handling the pollutants after their formation but before their discharge into the atmosphere, into our water sources, or onto the land. For many pollutants, there is experimental information which can be applied to the solution of particular environmental problems. However, the corresponding engineering technology either has not been developed or the economics are unfavorable by today's standards. The costs of the remedies thus far are not considered to be worth the gains. This should not be interpreted to mean that we recommend no further basic investigations regarding pollution abatement. On the contrary, it is reasonable to expect that a better understanding of the fundamental processes involved in preventing the formation of pollutants, or in disposing of the pollutants, would reveal more feasible methods for their removal by recognized engineering procedures. However, for most of the problems, there already exists appreciable scientific information on which to base larger scale work to improve engineering technology necessary for successful solution of the problems on an industrial scale. One reason for the large gap between scientific understanding and practical solutions is the fact that most pollutants released to the environment are present in low concentrations and require removal of small amounts of material from large volumes of harmless substances. Testing of prototype equipment or processes thus can involve treatment of huge quantities of materials at substantial expense.

SULFUR OXIDES

The problems encountered in lowering the amount of sulfur oxides which enter the ambient atmosphere offer a good example of the status of many of the problems in environmental pollution. I will, therefore, discuss this in more detail. The principal sources of sulfur oxides pollution are from the combustion of fossil fuels and from the metallurgical processes involving sulfur-bearing ores. Of these the combustion of fossil fuels constitutes by far the largest source. However, since fossil fuels are the basis for the production of the predominant share of the energy which keeps our industrial economy going, there is no way to eliminate completely the use of sulfur-bearing fossil fuels within the foreseeable future.