ample of the interrelated complexity of many of these problems. In solid wastes in general, one of the things we are doing at the moment is making a nationwide survey to reveal the magnitude, location, and composition of all major tailings dumps. From these we are getting samples which will be examined for mineral values and for ways and means of disposing of the waste.

One of the things we are trying to do is grow vegetation on various types of waste. If we can't do any thing else, possibly we can turn these piles from gray to green. They will at least be a little better looking from the standpoint of appearance.

Summarizing, it is believed that much scientific information is available on environmental pollution for application toward limiting the amount of air, water, and land pollutants which are a byproduct of our industrial system.

However, there is a great lack of engineering technology for successful abatement of many of the pollutants without putting an economic strain on the industry and public in general.

We believe that through continued research and development it will be possible to solve the problems confronting the Nation effectively and economically. However, such solutions must balance public need against economic considerations. In other words, the economists are telling us to use the principle of minimizing total cost. Total cost includes both economic cost and social costs and the commitment of resources costs. If cleaner air, water, and land is to be attained without disrupting the economy, increased efforts by both industry and Government will be required.

The conversion of waste materials into useful products will help minimize these economic burdens. The Bureau recognizes its responsibilities in many areas of pollution abatement and will continue to work for technically and economically feasible solutions to the pollution problems in these areas which confront our Nation.

Mr. DADDARIO. Thank you very much.

We have asked you a number of questions as we have gone along and you were extremely helpful to us.

Mr. Roush, do you have any further questions?

Mr. ROUSH. No further questions.

Mr. DADDARIO. Mr. Chairman?

Chairman MILLER. No, I only want to congratulate Dr. Hibbard for his very fine statement. I think it pinpoints much of the gaps in our technology as all of the statements have so far, but I think that's why we are having these hearings—to try to pinpoint some of these gaps.

I am conscious of the fact that to do many of these things is going to be costly. Who should pay for them? Should the general public pay for them in the price of an automobile? Should we include an increment to take care of the old car when it is run off the highway and has to be cut up? I can see where industry would complain, but some place these problems have to be solved and somebody has got to pay for them. I think this is one of the things we have got to begin to take a look at. We are interested in one phase of the problem, but the economics of the whole system must be given very serious consideration, too. Thank you.

Mr. DADDARIO. Mr. Vivian.

Mr. VIVIAN. I have several questions regarding mine drainage. Does mine drainage last more or less indefinitely? After mines open, how long will the drainage continue to run? For a hundred years?

Dr. HIBBARD. As long as water is flowing through the area, yes. Our problem is not with the mines operating today, but with the mines that have been abandoned and water has been flowing through them for 40 to 50 or more years.

Chairman MILLER. In the old times, this water found itself into other systems. What the mines have done is to break the pipe and tap it. The water is coming out now and there is no way of stopping it.

Dr. HIBBARD. And, this is why the first approach was to seal the mine. Hopefully the seal would prevent the water from getting into or out of the mine, but in many cases the situation is such that it is impossible with currently known means to do this.

Mr. VIVIAN. Every surface of a hill in a sense, is an open mine. So, presumably nature has been absorbing mine drainage for thousands of years, hundreds of thousands of years, and I presume what happens is that you have an accentuated rate of chemical contaminations in deep mines. Is that the problem?

Mr. PERRY. The mines that give you problems are those above drainage. If a deep mine below drainage gets filled with water, then the problem disappears. There are three elements that are required to make acid mine drainage. Ore is the pyrite, one is water, and one is air. If any one of these is eliminated then acid mine drainage stops so, over a long term, exposed sulfur compounds have been washed away and it is only by mining where you open fresh surfaces containing sulfur compounds that can come in contact with air and water that you have acid forming again.

Mr. VIVIAN. Is it particularly prevalent in the open strip mines which I see so often in the Alleghany area?

Mr. PERRY. It occurs there, too, but better methods of control have been developed for strip mines than for underground mines.

Dr. HIBBARD. In fact, with existing mine operations and anticipating the problem, you can frequently handle it as you go.

Mr. VIVIAN. I would like to ask about the subject of auto fuels again. What actual improvements has the Bureau of Mines been able to make in the treatment of auto exhaust?

Mr. PERRY. The Bureau's research has been financed principally by Public Health Service. Our work has been to identify the variables that affect the kind of products that come out. The product from an auto exhaust is a product of unburned hydrocarbons, stuff that comes through unchanged, partially burned hydrocarbons; and mixtures of these. The Bureau's role has been to actually try to identify the individual compounds and their relationship to fuel composition because this is variable depending upon the way you process it and the crude you made it from.

When an engine is accelerating, decelerating, or idling, the condition of the engine, type of engine, all of these things affect the nature of the waste product. Our role has been generally to identify the facts related to this so that abatement devices could be devised.

Chairman MILLER. Isn't it true that the condition of the engine has a good deal to do with it? I can't be critical because I have driven some old cars myself, but every once in a while you see a car going down the street that has loose rings and there is a cloud of gas behind it. I think if we could get rid of some of those things that pollution would be reduced a great deal. A car with a poor engine in it isn't consuming its gas. I would guess that it gives out as much pollution as maybe a dozen good cars with tight engines, isn't that right?

Dr. HIBBARD. I think this is one of the problems with the current devices which are being put on the 1968 cars. They require adjustments of the carburetor in some cases or the maintenance of the engine; and if the public lets some of these adjustments go by the board, the abatement devices will be a lot less effective than they might otherwise be.

Mr. VIVIAN. On the subject of auto exhaust as I understand it, your principal involvement is an analysis of the exhaust gas problem, not the development of new devices. Have you spent any funds in the Bureau on the development of new control devices?

Mr. PERRY. The only work that the Bureau has done on this was some afterburner catalyst work. One of the ways to eliminate pollution from this source is to take the unburned hydrocarbons and partially burned hydrocarbons and burn them in the exhaust pipe where they are changed to carbon dioxide and water. We did some early work for the Public Health Service with respect to use of catalytic afterburners and the testing of a number of devices. We have also worked on the development of catalysts that might be useful for this purpose, particularly ones which would be not sensitive to the lead in the fuel, which is the real problem with these catalysts. However, with the announcement that the automobile industry had found a solution to this problem, other than the use of exhaust devices, the interest in this problem declined, although I think it will step up again now. We have not been working on this for the last 2 or 3 years, but prior to that we did work on this problem.

Mr. DADDARIO. We have another witness and even though we have a number of other questions, I hope we might be able to submit them to you and get your answers for the record. Thank you ever so much, all three of you, for coming.

(Additional questions and answers for the record may be found in vol. II.)

(The biographical statement and complete prepared statement of Dr. Walter R. Hibbard follows:)

BIOGRAPHICAL STATEMENT ON DR. WALTER R. HIBBARD, JR.

Dr. Walter R. Hibbard, Jr., one of the Nation's outstanding metallurgists, became Director of the Bureau of Mines on December 1, 1965, following earlier successes as an educator, researcher and as an industry manager of scientific and engineering research.

Born in Bridgeport, Connecticut, January 20, 1918, Dr. Hibbard was graduated from Wesleyan University, Middletown, Connecticut, and received a Doctor of Engineering Degree from Yale University in 1942. Following his military service in World War II as an officer in the Navy Department's Bureau of Ships, he joined the Yale faculty as an Assistant Professor and later became Associate Professor.

Dr. Hibbard's growing reputation in teaching and research attracted industry, and in 1951 the General Electric Company enlisted him for its Research and

Development Center in Schenectady, New York. There he progressed to the position of Manager of Metallurgy and Ceramics Research, which he held until he was beckoned to public service by President Johnson as Director of the Bureau of Mines.

As an expert in such fields as the plastic deformation of metals and the metallurgy of copper and its alloys, Dr. Hibbard won wide recognition from many professional societies. In 1950 he received the Raymond Award of the American Institute of Mining, Metallurgical and Petroleum Engineers. From 1957 to 1961 he served as a director of the Institute and is now its President-Elect for 1966. In addition, Dr. Hibbard belongs to the British Institute of Metals and the New York Academy of Sciences, and is a fellow of both the American Academy of Arts and Sciences and the American Association for the Advancement of Science. He is a member of the National Academy of Engineering. He also is a member of the Materials Advisory Board of the National Academy of Science, and is currently its Chairman.

Dr. Hibbard has been elected to many honorary and professional fraternities, including Phi Beta Kappa, Sigma Xi, Alpha Chi Sigma, and Gamma Alpha. He is the author of more than 70 scientific papers and has been widely recognized as a major contributor to the science of metallurgy.

Dr. and Mrs. Hibbard have three children and reside in Rockville, Maryland.

PREPARED STATEMENT OF DR. WALTER R. HIBBARD, JR., DIRECTOR, BUREAU OF MINES, U. S. DEPARTMENT OF THE INTERIOR

INTRODUCTION

I am pleased to have the opportunity to appear before you to discuss the technologic problems facing the nation in its efforts to abate environmental pollution. According to reliable estimates, the combustion of fossil fuels produces approximately 130 million tons per year of contaminants, the larger portion of which is released into the atmosphere. Of these contaminants, approximately 85 million tons result from the combustion of fuel in all form of transportation including trucks, buses, railroads, and airlines. It is estimated also that over 23 million tons of sulfur dioxide are discharged into the atmosphere annually from the combustion of fuels for heat and power purposes and from industrial operations such as the metallurgical processing of sulfide ores. Thus, automobile exhaust and sulfur dioxide pollution produce approximately 83 percent of the total amount of contaminants emitted to the atmosphere from fuels combustion. Because the automobile engine and the sulfur dioxide from conventional fuel combustion constitute the principal source of pollution to the atmosphere, efforts in air pollution abatement have been largely concentrated on these two problems. The wide dissemination of information on the subject and increasingly severe effects of air pollution in highly industrialized areas have resulted in public demand for increased efforts to eliminate or control the pollution from these sources.

Mining, mineral processing and refining of mineral substances are processes conducted for the purpose of separating a usable product from the accompanying useless substances. Additionally, many initially useful products become waste after varying periods of use. Normally, the useless products are discarded by the least costly methods in the interests of economy. Thus, the mineral-based industries contribute a large part of the waste products that in some instances accumulate in a manner inconsistent with public interest and welfare. Because waste disposal problems and practices vary widely, the rapid accumulation of mining and processing waste and metal scrap has become a social and economic problem of considerable magnitude. In many cases these wastes represent a serious loss of natural resources unless methods are found to reconvert into useful products. The technology by which mineral wastes of all types can be conserved is a problem of primary importance to the Bureau of Mines.

The contamination of our water supplies by drainage from both active and abandoned mines is a problem of national importance. Many streams, particularly in the Appalachian region, have become unfit for most aquatic life and of questionable value for industrial use. However, practical solutions for many of the problems of acid mine drainage are either unknown or of doubtful value at the present time and must await future developments.

THE ADEQUACY OF TECHNOLOGY FOR POLLUTION ABATEMENT

WEDNESDAY, JULY 20, 1966

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT,
Washington, D.C.

The committee met, at 10:10 a.m., pursuant to notice in room 2325, Rayburn House Office Building, Washington, D.C., Hon. Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. DADDARIO. The meeting will come to order.

The testimony which the subcommittee will hear during the next 4 weeks will concern the adequacy of technology for the abatement of environmental pollution. The problem of pollution represents the other side of the bright coin of American civilization. On one side we see the benefits of the application of science and technology in our standard of living, our national security, our economic growth, and our prestige, among nations. But, on the reverse of the coin we must recognize the unexpected and unwanted consequences of a technical society—such as urban problems, transportation complexities and most importantly, the threat to the quality of the environment.

I believe at the outset that the question is not one of either curtailing industrial and economic progress or suffering the decline of air, water, and land quality. It seems clear that we should not, and need not, settle for anything less than wise usage of all our resources for the optimum benefit of the economy and all our citizens. This means that the restoration and preservation of air and water are a logical adjunct to the building of cities, the providing of electric power and personal transportation, and the development of agricultural and manufacturing businesses.

Sober consideration of the waste-products problem is a responsibility of us all, but it is not an issue which should be treated in an atmosphere of crisis where blame is placed or ill-considered remedies hastily enforced. These hearings are designed to make clear to the Congress the technological problems of pollution abatement and research needs. It must be realized that any definition of pollution is relative to the specific use among various contending needs of society, to which a particular stream or area is dedicated. Quality criteria and standards permit meaningful goals and timetables to be established and new technology to be developed for pollution abatement. These hearings are designed to anticipate the problems of the future. One thing that is clear is that we will have to emphasize greater reuse of our resources in the future.

Much significant legislation for control of environmental pollution has been passed. I am pleased that we will hear this morning from the leaders who have drafted these pace-setting laws. What remains to be seen is how political, economic, and technical institutions can organize themselves for an efficient and equitable response to this public purpose. I am convinced that the community of scientists and engineers which has brought about the high level of our industry-based society will also be able to solve the problems of waste management. These solutions must be solidly based on fact or our goals and the timetables for meeting them will not be achieved.

In many cases the technology is now available to abate pollution—and should be used to do so. In other cases, the devices and techniques are inadequate or far too costly and more research must be done. The subcommittee has had valuable counsel from the Research Management Advisory Panel which has studied this problem for some time. The panel has indicated that abatement of pollution is a crucial area for study by this subcommittee. Such consideration is consistent with the statement by Chairman George P. Miller 3 years ago that one of the primary objectives of this subcommittee is "The achievement of the most effective utilization of the scientific and engineering resources of the United States in the effort to accomplish national goals which affect the lives of all Americans."

Such national goals as pollution abatement are properly comparable with goals in military security or space exploration. Science and technology are not, however, parceled out among these goals on an arbitrary basis. Rather, the goals are assigned an importance and a corresponding priority within the entire Federal program. Then, those goals which require a high degree of support by research and development are provided funds accordingly. The priority of the pollution abatement effort is rising as knowledge increases and apathy is replaced by a call for action. These hearings will indicate whether there is an adequate Federal effort, as well as privately financed research and development, now going into pollution abatement to assure the attainment of appropriate and desirable national goals.

Significant to this point are the results of a survey of 1,000 participants by the magazine Industrial Research in its July 1966 issue. To the question "Is the Federal Government spending too much on R. & D. for space?", 46 percent responded "Yes" and 47 percent responded "No." To the question "Is the Federal Government spending too little on R. & D. for pollution?", 67 percent responded "Yes."

A direct example of the need for new technology is found in the recent announcement by President Johnson on the control of air pollution originating from Federal installations. The President said that the most difficult problem encountered in writing the order directing Government agencies to lead the way toward clean air, was the lack of an economically feasible technology for controlling the emissions of sulfur.

Thus, there is evidence that the technology to achieve our objectives of environmental quality and waste management is not yet adequate. In these hearings we will hear from scientists and engineers who are engaged on a day-to-day basis with this problem.

I might say that environmental pollution is no stranger to us in Connecticut. For example, our most valuable cash crop, tobacco, can

be severely damaged by ozone originating in automobile exhausts. Several ozone-resistant strains of tobacco have been developed. However, even these varieties are not immune, and will be damaged if the concentration of ozone in the air becomes too high.

What technology is available to protect this crop, or to reduce the exhaust emissions, and with what cost effectiveness? Can further research bring some new imaginative solutions to this conflict of agriculture and transportation values? These are typical of the questions these hearings will explore.

Further, I believe that pollution is just one example of the need which we have for greater insight into the undesirable side effects of manmade changes in our world. Dr. Jerome Wiesner, a member of the Advisory Panel has used the phrase "early warning system." As the growing population of the world brings human society to every geographical area and as the world becomes more industrialized, the potential of mankind to create worldwide problems such as radioactive fallout, spread of persistent pesticides, and a carbon dioxide imbalance in the atmosphere, also increases. Our ability to study and to predict the effects of these vast ecological manipulations before they threaten our well-being has become crucial. This is indeed a challenge worthy of the best of our scientists and as exciting as the conquest of space.

We must replace emotional response, which comes all too quickly in environmental pollution issues, with facts. We must replace an atmosphere of crisis, which is a poor one for decisionmaking, with confidence in cause and affect relationships. We must do our utmost in developing new waste management methods and in removing barriers to their application. We must also help define the problems through the formulation of realistic standards by which we can judge our current situation, our progress, and our needs. It will then be possible for continued economic growth to be accompanied by a high level of quality in the air, water, and soil.

I'm pleased that to begin our hearings our first witness will be Congressman John A. Blatnik, of Minnesota, who is chairman of the Subcommittee on Rivers and Harbors, Committee on Public Works.

Mr. Blatnik is an old friend of mine. I have watched very carefully and supported the work he has done in this whole area of pollution. Over the course of many years he has been the instigator of a tremendous amount of activity which has been helpful to many of our States.

Mr. Blatnik, we are happy to have you here and we are anxious to have you be our leadoff witness.

STATEMENT OF CONGRESSMAN JOHN A. BLATNIK, CHAIRMAN, SUBCOMMITTEE ON RIVERS AND HARBORS, COMMITTEE ON PUBLIC WORKS

Mr. BLATNIK. Thank you very much, Mr. Chairman and members of the committee.

I'm very privileged indeed to appear before the committee on the subject area of particular special interest and concern to me for some years. I am certainly honored to be the leadoff witness. Exactly

what that means, I don't know. The man I am sitting with, my colleague and dear friend for 20 years, Mr. Robert E. Jones from Alabama, I say for the public record here not because he is here, but by far he knows more about all aspects of water utilization and preservation than any other Member of the Congress.

I have a very brief statement, Mr. Chairman, and I ask unanimous consent to be permitted to extend and revise it. I am not an engineer, but my undergraduate background was chemistry and physics. My dreams years ago was to be a biochemical researcher. I do have a very keen interest in this problem.

Your opening statement was as pertinent and concise as I have heard. It is an insult to the testimony of what I hoped to be able to say, which is not nearly as complete as your statement.

A greatly expended research and development effort is needed if we are to solve our water pollution problems in an effective and economical manner. Our best efforts with the limited funds available have done very little more than to assess the magnitude of the problem and to demonstrate the harmful effects of pollution.

I think now we have at least an awareness across the country on the part of the people and a better understanding of the technical people and sanitation engineers and other hydraulic engineers on the need for more work in this complex and complicated field of pollution. I think one reason we are in this situation is merely through inadvertent neglect to water in its original relatively abundant form was taken for granted as much as we take air next to us for granted. Yet, if you are deprived of air for a few minutes, you are dead. You can live a little bit longer without water, but water is more essential than food and you can get along without food more than you can without water. Because we have this carryover, we think water is abundant. We don't realize that we have to do something about it. Too, in other areas where shortages have occurred whether it be in gasolines or propellants, fibers, food, you name it, you have always found a substitute or synthetic, but we find out now we cannot do anything with water. You can't find a substitute for it.

You can't do anything with this water. You can't squeeze a drop of water out of a glass of water, because we tried. We have one-half of all the peat in the States in my area. You can have cheap power if you can burn it, but you can't squeeze water out of it. The main problem is not that we can't do anything about it and that we shouldn't. We know that we should and can. The main problem we have now been stimulated to an effort and we are approaching that point now, stimulated to a point to exert an all-out effort. Any research requires an all-out effort if you apply human ingenuity long enough, and that means you can solve the problem of thermonuclear energy. You will solve the problems of space, or auto service mechanisms, complicated and fantastic alloys that didn't exist a few years ago, heat resistant alloys. All the matters of which you committee members are far more familiar with than we are.

In water, we are using processes today—they are mechanical improvements or refinements of basic processes of water pollution abatement. I am talking of municipal facilities for human waste, primarily. They are merely mechanical improvements in refinery or basic technics used half a century ago.

It is incredible that we let that long a lag develop in this area. We have pumps that pump more water at a faster rate per minute, more cubic feet per minute. We have filters that will filter faster and perhaps a little better but basically it would be as though you have a refined kerosene light or refined gasoline motor. We are already working on thermonuclear powered motors as you well know, using water and steam like the old Stanley Steamer. It is more efficient and smoother than the internal combustion engine. Let me give an example of what I mean, not only a need for concentrated effort, but new concepts of the situation. You have to have brains working to develop new ideas. In the field of iron and mining—and I mention it because I see my friend from Michigan, Mr. Vivian, here who knows the problem in the Upper Peninsula of his State—we had the exhaustion of ores over the years and they run out of natural ores. That sort of broke up the monopoly that our part of the country had in the world, but we went to work a few years ago in tagonite. It is one of the hardest rocks that exists, harder than granite. As long as man has drilled holes into rock or made beads, he had to use the principle of a harder substance wearing down a relatively softer substance, and over the years we developed what is called the diamond drill. It is the hardest drill known, and that was a great achievement, but here we use mining the diamond drill for 50 years and we got a hold of this tagonite and it will take a whole day to drill a 2-foot hole. Obviously we are stuck. Technology, the best available engineering technology up to that time, 10 years ago had us right against the wall. We had this unlimited amount, billions of tons of tagonite, and we couldn't drill holes to blast it.

Suddenly people in the Midwest who have been working with oxygen trying to sell more oxygen and then they developed a kerosene burner, simple cheap fuel, utilizing oxygen with three flames, similar to the old stip water sprinkler. You remember the old—we do, the older members, the three prong water sprinkler that we had that would sprinkle the lawn. They rotate this and it melts the rock at the rate of 20 feet 1 hour. It didn't have to grind it. It melts it just as smooth and efficiently and cheaply as anything that has ever been done. And, more than that, they found out that the rock being very hot, the core being hot, the rock would fracture by itself, and steam pressure blew it out and cleaned the hole out. That's a little example of what has happened to literally put the processing or manufacturing of iron ore over the threshold of economic feasibility as well as the technical feasibility. So, that's the type of thing we ought to be doing in water pollution, research in so many many areas. To give you an idea of the level of research just in the pollution control agency, I know there was research done by other agencies of the Government, about 16 or 22 of them. I think 5 years ago our committee authorized $5 million a year for—Mr. Waggonner was one of the early supporters in our program for research in different aspects of pollution abatement, but the appropriations came about first a million and then two and three and gradually last year it reached approximately $5 million which is far too low. We are now aiming in the current legislation around $50 million, and that in itself would not be enough, but if we utilize the knowledge that has been developed by the other agencies,

space, NASA is one, and research going out and coordinate it, other agencies on the Federal level, universities and industries, we can more efficiently utilize the research going on in other areas rather than duplicating inadvertently. We have to encourage new approaches, new ideas, consistent and persistent and concentrated attack on this whole problem.

I want to list very quickly some of the major problem areas. First, municipal wastes. That's what I had in mind when I said we haven't changed anything in the last half century.

You have industrial wastes, including thermopollution.

There is storm and combined sewer wastes. To show you what a frustrating problem this was, we have now I believe $20 million for demonstrations to help solve this enormous problem and we can't find anyone that will even apply for it. I think we have two applications for demonstration grants. One minor one was finally granted. It will cost roughly $2 million for the primarily larger cities to solve their storm and combined sewer wastes.

There is also wastes from boats and ships, household or isolated small system wastes, animal feed lot wastes and drainage.

There is agricultural runoff, acid mine drainage, silt from construction projects, quality changes in impoundments, and accelerated and natural eutrophication.

We were at that lake between Nevada and California—what is it?

Mr. WAGGONNER. Tahoe.

Mr. BLATNIK. Tahoe, and I think Mr. Jones was there 8 years ago when a highway system, interstate, running north of it from Reno to Donner Pass. We drove around it and we were back early this year at the invitation of the California Congressmen, and we were shocked at what was happening to one of the only two Nation's lakes, or Alpine lakes as sometimes called, in the North American Continent. Perhaps there are only three in the world. Already the algae is beginning to grow and in a few years this deep, ice-cold, blue lake will become a mass of green and, when all the oxygen is gone, it will come a stinking mass of brown. It is already starting like it is in the early stage, and if anyone told me 10 years ago that recently when we first started with water pollution controls on rivers and harbors that one of the five Great Lakes, one of the largest bodies of water in the world, would become a dead lake and it is more than that now, I would say you are crazy. It will cost us about a billion dollars to undo the work that has been done there.

The same thing with the Hudson River. The Congressman from New York knows the problem pretty well. There is plenty of water, but not a drop to drink. It has been fouled up so we have a tremendous great job to be done. It will require the coordinated joint effort in the Federal, State, local and industry. I know this sounds like nice words. It sounds like sort of a passing away. But, it has been done, I am saying. It has been done in the highway program, the largest public works program ever undertaken in the history of mankind. Largest multibillion-dollar peacetime tax program ever sustained, ever adopted by Congress and supported by the citizens of America.

Today we come up with a highway bill running into a couple billion dollars on the floor of the House, and it almost passes by unanimous

consent. It shows the people will support a program of magnitude running in the order of billions of dollars and that program can be worked out in a joint effort as has been done in the highway program. You have got to concentrate—I am trying to summarize very quickly. One more new process.

Carbon is a very effective filter and although very expensive, they are reducing the cost now. Carbon will filter gases and the scientists will appear next week to find out whether finely powdered coal will work. Some of the new ideas, such as carbon absorption, the use of coal for filtration and absorption, new coagulants, sludge disposal in strip mine areas, electrodialysis and reverse osmosis should be subjected to field study as rapidly as possible. The Federal Government, through Interior, is subsidizing on a larger scale than before, and what works very well in the laboratory will not necessarily work too well in the field.

The solution of water pollution problems will require not only the development of adequate techniques, but also their application. Research and development activities generally progress through a series of steps ranging from exploratory to laboratory research to field evaluation and demonstration. Field evaluation and demonstration studies require that new type facilities be constructed and operated under actual field conditions, which is generally very expensive. I am not advocating this particular process, but in short, here is someone suggesting or attempting a new type of idea, merely using plain pulverized coal in which you have an abundance and it has an economic need as the Appalachian program showed.

They can skim off the contaminated top layer of coal and burn it up in a furnace and generate power and steam so municipality or industry will get its money out of coal or the organic material absorbed. So, Mr. Chairman, with the fund of knowledge we have today there is no reason and no excuse for permitting what is an absolute necessity, the water in abundance for effective and efficient reuse of what water we do have, as you stated in your very fine opening remarks. Here we have today more than 95 percent of all the scientists that ever lived in the history of mankind alive today, and I think my interest in medical chemistry, I believe I am correct in using these figures, 75 percent of all the prescriptions used to date were not in existence at the close of World War II, about 20 years ago.

Talking about the volume of knowledge that is being found today, a new communication concerning chemistry is published somewhere in the world every minute, a report on physics every 3 minutes, and a report on medicine, biology, and electronics every 5 minutes. To give an idea of the rate information is being made available, I read recently that if a man started at the first of the year to read everything new in chemistry as it was published, by the end of the year he would be 10 years behind.

To show you the availability of this knowledge around us and it can be done systematically and effectively, using all the knowledge found in these different agencies, so I strongly urge this inquiry. I hope and know it will be a productive one. I strongly urge support to both the basic science and research and to the applied research and demonstration programs in the field of environmental problems, more particularly to water pollution.

The problem can be licked and will be licked—remember in the highway program they said we couldn't afford it—and the economic savings will be $5 million a year on the program which the Federal Government is putting about $4 billion, plus saving about 10,000 lives each year on the highways. In the last 2 weekends on Christmas and New Years combined we killed more American people on our streets and highways and byways at home than were killed the whole previous year in Vietnam in the war. We have that type of slaughter in 2 weeks.

In Vietnam we would be ready to drop the atom bomb, there would be such a furor. Yet it happens at home and you are lucky to get 3 inches of space on your newspaper.

Mr. Chairman, I appreciate the patience of the members putting up with me, and the chairman for giving me this time.

Mr. DADDARIO. Mr. Blatnik, you have given us a very exciting and helpful statement. I wonder if you might comment on your trip to Germany this year when you accompanied the Secretary of the Interior. I am particularly interested in the way the technology development is funded.

Mr. BLATNIK. Mr. Chairman, Mr. Jones made that trip; although I was asked to go along at that time with him, I couldn't.

Mr. DADDARIO. I know Mr. Jones was on the trip and I thought you were too.

Mr. BLATNIK. No; I couldn't make it.

Mr. DADDARIO. Fine. We will wait to hear from him.

Mr. BLATNIK. You were working with desalination on arid areas which is extremely important, but at the same time we also ought to be working in these arid areas where we have an abundance of gas and petroleum on burning, you know, human waste which can be done very effectively. All you will have left is steam and dry ash that goes up into the air and here we are working at great expense to get water through desalination which is important and needed, but to use that expensively produced water as merely a conveyance to carry away human waste and then build other plants in addition to remove that waste doesn't make sense.

Getting back to this idea for needs of new concepts and breaking away from the old stereotypes is another matter I would like to mention.

Mr. MOSHER. Mr. Blatnik, did I understand you to say your committee is asking for $50 million?

Mr. BLATNIK. It is not that our committee is asking for it. It is legislation before us and also has been before the other body that calls for that amount of money.

Mr. MOSHER. How would this be administered?

Mr. BLATNIK. Through the water pollution administrator which is now in the Department of Interior.

Mr. MOSHER. Is the Congress likely to appropriate $50 million for this purpose?

Mr. BLATNIK. I hope. Speaking only for myself, I shall urge it, and I think we have good enough case to support it.

Mr. MOSHER. How much has that agency been using in the past? How much is it using this year?

Mr. BLATNIK. Under $5 million. It was authorized about 5 years ago, but your appropriations were at a low level beginning at a million,

approximately. I will get the correct figures, but we authorized $1, $2, and $3 million, and finally last year built up to $5 million.

Mr. MOSHER. And, you are asking for $50 million now?

Mr. BLATNIK. Right.

Mr. MOSHER. That would be a very significant increase. A lot of work could be done for that amount of money.

Mr. BLATNIK. That is right.

Mr. DADDARIO. We will be having Dr. Weinberger, who was Assistand Commissioner for Research and Development for that program before us on the 27th of July and we can go into that program with him.

Mr. MOSHER. One other clarification, Mr. Chairman.

Mr. Blatnik alluded to one of the Great Lakes which he said was dying. I assume he is referring to Lake Erie.

Mr. BLATNIK. Yes, sir.

Mr. MOSHER. Lake Erie is in my domain, and somehow I shudder at the use of the word, "dying." I think that is a little exaggeration. Nevertheless, it is a serious problem and what is going on there is very bad. You said there is a rough estimate that it would cost a billion dollars to reverse that process in Lake Erie.

Can you give me a specific reference to that estimate?

Mr. BLATNIK. Yes. It would involve—these are preliminary, sort of somewhat speculative, but fairly accurate in dredging the sludge out of the bottom and getting the gook in fluid to settle to the bottom. The gook is settling and slowly moving up and that's why it is dying, and no oxygen—fresh water being lighter like milk being over cream merely floats like a saucer floating maybe 50 or 60 feet deep. So, the fresh water goes down into the Niagara and Ontario and so on, but whereas this gook getting higher and higher, inching up and over a few years you will have a dead lake on your hands. The process is getting worse year by year.

Mr. MOSHER. It is a very serious matter. Can you give me a specific reference to someone who has proposed this means of cleaning up the lake that you suggested?

Mr. BLATNIK. Yes.

Mr. MOSHER. I would like to get that.

Mr. BLATNIK. Mr. Jones tells me there is a survey resolution perhaps before this subcommittee, the resolution itself calling for a study of the problem. The study itself will cost $5 million. We will also get you the sort of preliminary information and judgment available now from the Corps of Engineers, and water pollution abatement people.

Mr. MOSHER. I'm going to ask the committee staff to get this information for me. There are several studies going on already as you know. (Information separately provided to Mr. Mosher.)

Mr. DADDARIO. Any further questions, gentlemen?

Mr. WAGGONNER. Mr. Chairman, I would like to thank and congratulate Mr. Blatnik for being our leadoff witness this morning. We are talking specifically now about water pollution in which he is more than well informed. I think he has set the stage for us to think in big terms about pollution abatement. I don't think anybody claims that we have the adequate technology now for the pollution

abatement in the area of water pollution or any other particular area. I completely agree with him that there is no reason or excuse to accept the status quo if we are going to even think about today much less tomorrow. He has certainly done more than his part to awaken people to the perils of all kinds of pollution. His committee has finally, I think, awakened the Congress to the needs of the country in water pollution. I just have one comment and that is that we in Congress and the people in the country have accepted Federal and joint programs wherein we can build water resource projects and watershed projects, but we have not given the proper attention to these God-given streams and lakes that have been ours through the years. We are more interested in developing new projects than we are in preserving and maintaining for future generations those which have been with us all the while.

So, I think that Mr. Blatnik has brought to this committee the leadership he has been exercising in his own committee through the years.

Mr. DADDARIO. Mr. Vivian?

Mr. VIVIAN. The gentleman from Minnesota has touched upon quite a number of items, some of very great interest in my own district. Lake Erie borders my district. The "deadest" part of Lake Erie lies just off of the shores in my district.

The comment you made that the layers of water below the surface of Lake Erie are growing increasingly stagnant, is most pertinent. When strong winds blow in from the east toward the beaches in my district, the beaches become littered with various and sundry forms of marine growth and sludge from the lower levels of the lake. Even on quiet days, the water is turbid. Along the beaches signs are posted year after year saying "Not safe for swimming."

Now the question which I really want to get to is what will it cost to clean this vast lake and its neighbors, and how can we reduce that cost by intelligent actions now? According to an estimate made for me by competent persons from Federal agencies, it will cost approximately $5 billion over the next 20 years to clean up Lake Erie. Part of these funds will be used for replacement of wornout sewage treatment facilities, and part for installation of new facilities. Extended to all the Great Lakes, the estimate was some $20 billion; extended to the entire Nation, the estimate rose to about $100 billion, an enormous sum. But, as you pointed out, that amount is comparable to the $40 billion we have spent on roads in the last decade, so the total cost and the rate are not at all unreasonable, in terms of our capabilities.

Now, let me ask, is there any evidence available to your committee that this great sum could be reduced to a more nominal figure by any research now in progress? Such as, for example, the research underway on the powdered coal sewage treatment process? I understand that the optimistic proponents of this process expect to reduce the cost of treatment of sewer wastes to about half; conversely, detractors dispute that claim, and argue that little or no money will be saved.

Mr. BLATNIK. That is the expected gain, and the laboratory model suggests that reduction would be correct, but to prove it out, you have to build what we call demonstration or semicommercial or pilot models, larger models. You have a continuous flow and much larger

scale, then you can refine your figures as to cost more accurately and quite often they are quite a bit different than what happens on a laboratory model.

Also, it just won't work on that large scale. But, you have to get into that expensive effort to prove out because anything can be a massive program. You can't build highways or do thermonuclear stuff or space program on a small scale, so this too will be a billion dollar scale.

Mr. VIVIAN. One of the communities in my district is very deeply interested in this powdered coal process. They and I have had many, many talks with engineers on the subject. The savings expected seem to grow less as the conversions go on. But, I think it is pertinent to point out that, considering that the potential cost of the total program will be something like $100 billion over the next generation, even a 10-percent savings through improvement such as the coal process may offer, could save us $10 billion, an amount enormously greater than the amount we are talking about for research.

Let me turn to another question.

Many of us are aware that much of the water used in the United States are used simply for transportation. It is a convenient fluid in which to move various materials, from paper pulp to human waste.

In coastal areas, conceivably we could use ocean water for many such purposes, rather than wasting river water. Has your committee given any consideration to installing supplementary salt water distribution lines in coastal areas?

Mr. BLATNIK. Yes. I believe Mr. Jones of Alabama, who will follow me, will discuss that subject.

Mr. DADDARIO. Mr. Ryan?

Mr. RYAN. I would like to join with my colleagues in commending Mr. Blatnik for his very splendid statement before the committee this morning and his great experience and devotion to this cause. He is certainly one of the leaders in the country in this whole question of pollution abatement. I believe with Congressman Vivian and Congressman Waggonner that we must recognize that this is an area where we must pool our resources if we are to meet with this problem. Congressman Blatnik has been one bringing this to public attention over a period of time.

Mr. BLATNIK. Thank you.

Mr. DADDARIO. Mr. Conable?

Mr. CONABLE. I would like to thank Mr. Blatnik, too. I would like to follow up on some of the implications of what Mr. Vivian asked.

As I see it, we have two problems. One is the problem of developing techniques and the other is the problem of investing the money in the necessary capital equipment to carry out and to exploit these techniques.

Now, apparently your committee feels that we need a substantially increased outlay on research at this point in the development of new techniques. Is there an implication that we should go a little slower in investing in the pollution hardware so to speak, before we are sure that we have arrived at the best techniques available? I feel the American people want something done now.

They are concerned about pollution as its exists right now, and yet apparently we have been neglecting the scientific aspects of pollution control and thought in terms only of existing techniques.

Now, what about the time table on this? What about the priorities. Do you have from your prospective as chairman of your subcommittee, any words of advice for us on this?

Are we ready to go ahead with a massive expenditure on water pollution or should we make our massive expenditures in research first?

Mr. BLATNIK. It won't be quite that precise. It won't be like starting a race where you shoot a pistol and you are off to the race of a massive program. No. 1, you are spending on municipal waste alone about three-quarters of a billion dollars a year now on some Federal grants and primarily municipal grants, so you are already in the billion dollar range now and the spending will continue if nothing is done by the way of further research.

For instance, you don't hold back from buying new automobiles this year because 3 years from now a new jet-type automobile might come out. See, the need is there, and with more and more enforcement on the State and certainly the Federal level, whatever means are available for pollution abatement will have to be put into use.

They may not be the best but they are the best we have, so the current facilities will be continued right along. We hope to greatly accelerate research and better refined methods on the continuing program.

Mr. DADDARIO. The point you made earlier is that increased public awareness would allow us to use some of the techniques available to us now which are not being used.

Mr. BLATNIK. That is right.

Mr. DADDARIO. And, you go from there into more sophisticated areas of research over a period of time.

Any further questions, gentlemen?

Mr. Blatnik, thank you. We are pleased you took the time to come.

Mr. Jones?

Our next witness is Congressman Robert E. Jones, Jr., from Alabama, who is the chairman of the Subcommittee on Natural Resources and Power of the Government Operations Committee.

He is well known to our committee because he represents the Huntsville area and therefore has been extremely close to us over the course of years. He has been in Connecticut as chairman of the Subcommittee on Natural Resources and Power, holding hearings on occasion, calling attention to the people of my State of the importance of natural resources and power. We in Connecticut, are appreciative, Mr. Jones, of the work you have done in that area and the help you have been to us and to the entire country. I am sure that Mr. Roush, who was on that subcommittee, would like to say something further.

Mr. ROUSH. Mr. Chairman, I would like to join in welcoming one of my other subcommittee chairman to this committee and as a participant in these hearings. I feel very fortunate to have had the opportunity for several years now to serve under the leadership of our colleague from Alabama, Mr. Jones. Those years, for the most part, have been devoted to one of the subjects we are dealing with here today,

namely, the question of water pollution. Under Mr. Jones' leadership we have held hearings all over the country in such locations as Seattle, Austin, Chicago, Trenton, Hartford, Muscle Shoals, and here in Washington. On Friday of this week we go to Rochester, Toledo, and then to Syracuse. I'm sure that this committee will benefit greatly from the experience that Mr. Jones has had as the chairman of the subcommittee on Natural Resources and Power of the House Committee on Government Operations.

He is wise and knowledgeable on this subject, and I am delighted that he has voluntarily appeared before this committee to testify today.

Mr. DADDARIO. Thank you, Mr. Roush.

Mr. JONES. Thank you.

Mr. DADDARIO. Mr. Jones; please proceed.

STATEMENT OF CONGRESSMAN ROBERT E. JONES, JR., CHAIRMAN, SUBCOMMITTEE ON NATURAL RESOURCES AND POWER, GOVERNMENT OPERATIONS COMMITTEE

Mr. JONES. Thank you, Mr. Chairman. Mr. Roush and Mr. Blatnik, I don't believe a word that you said, but I would have been terribly disappointed had you not said it. It's a little bit refreshing, Mr. Roush, when you said invited to this committee; an invitation is a command, I'll assure you, sir. As the chairman has stated as long as Huntsville is involved in the space program to the extent it is, and I feel like probably this statement is sufficient and I should take my leave because I see with the interrogation that is taken place, people like Mr. Roush who are far more knowledgeable than I, are going to put me to task. I was pleased particularly, Mr. Chairman to hear your opening statement because it was exciting, it was a challenge to the committee, the subcommittee in exploring every possible potential of research and technical advancement in the water pollution field.

I am delighted to be here today to discuss some of the problems of water pollution control and abatement with particular emphasis on the vital role of research and development.

Your subcommittee, Mr. Chairman, is performing a signal service for the Nation through its study of the application of science and technology to the national program of water pollution control and abatement problem. You are getting at the heart of the critical problem which we face.

As chairman of the Subcommittee on Natural Resources and Power, I have been in close touch with developments in the water pollution field. Our Nation today faces a water shortage—a shortage of usable, clean water. Water pollution has become the Nation's single most desperate natural resources problem.

This pollution threatens the public health, jeopardizes our water supplies, destroys aquatic life, sullies our environment. Almost all of our major streams and rivers and lakes are suffering from increasing pollution.

Many of our rivers and lakes today are nothing but wet deserts. There is abundant water present but it supports almost no life.

The increasing pollution of our waters is costing us dearly—dearly in dollars and cents. The economic loss is incalculable. Each and all of us is affected by this enormous loss and cost.

In recent years we have mounted a national campaign aimed at water pollution control and abatement. The Federal Government, in cooperation with State and local governments, has launched a broad program for the construction of treatment plants. Federal funds have been provided for research and development in pollution abatement.

The overall program is commendable and certainly a step in the right direction. We have made progress.

But, unfortunately, our pace remains too slow. We are not keeping up with the growth and the enormous demand. I sometimes think we are trying to win the race with a Model T.

For example, millions of dollars are being spent to construct conventional treatment plants which do not do the whole job. It is well known that conventional waste treatment processes fail to eliminate at least 10 percent or more of the suspended solid wastes and other organic matter and also fail to remove metallic salts and certain other chemical pollutants.

In addition, I want you to remember this figure, 1,940 cities in the United States have combined sewers which commingle sewage and storm waters and permit untreated sewage to bypass treatment plants and discharge directly into our watercourses. These sewers flush about 65 billion gallons of raw sewage annually into receiving waters.

It would cost Mr. Blatnik about $30 billion to eliminate combined sewers in the United States.

For instance, we go to Rochester, Mr. Conable, in your area in that city alone it would cost half a billion dollars to correct the situation of a combined storage sewage which was built in about 1900.

Fortunately, the seriousness of the combined sewer problem was recognized in the Water Quality Act of 1965. The act established a 4-year program of research and development grants to demonstrate new or improved methods to eradicate the combined sewer problem. For this purpose, Congress voted an annual appropriation of $20 million for fiscal years 1966 through 1969.

The Government Operations Committee recently issued a report entitled "Separating Storm and Sanitary Sewers in Urban Renewal." The report was based on a study by the Subcommittee on Natural Resources and Power.

Recommendation No. 2 of the report states as follows:

> The combined sewers demonstration grants program should be expanded and accelerated, and increased emphasis should be given, through both laboratory and field research and engineering studies, to develop improved methods of controlling pollution resulting from the existing combined sewer systems.

If we are to make real headway in pollution control and abatement, it is imperative that we step up this research and development program.

The same is true with other aspects of pollution control and abatement. It is becoming increasingly clear that conventional waste treatment processes are not doing the job. New processes, then, must be evolved through accelerated research and development programs.

In recent years, water pollution control and abatement has become recognized as a worthy and desirable national objective. But it still

has too low a priority in our national planning. We should raise this priority.

In the national planning and its implementation, I firmly believe that industry should be given a larger role. Industry is responsible, in part, for the existence of the pollution problem. At the same time it has done much to eliminate pollution. Industry is close to the problem and is knowledgeable in the water pollution field. I believe it should expand research and development programs and I believe the Federal Government should support this expansion in dollars and cents and technical services.

We are barely able to keep pace with water pollution problems as they arise at the present level of effort. Certainly, there is need and justification for at least tripling our research and development to contain the pollution problems at hand. We may have to increase our present efforts tenfold if we are to make significant advances toward a final solution.

It is abundantly clear that new ideas, new approaches are required in the field of waste collection and treatment to keep level with population and industrial growth. And this is why the Federal Government can no longer be niggardly in underwriting research and development programs.

At the same time we must push ahead with our present programs, particularly in the fields of treatment plant construction and in the field of enforcement. We must continue to fight with the tools we have until we have better tools. For example, I have pointed out that it would cost some $30 billion to separate the Nation's combined sewers. Obviously we have a cost barrier here, because we can't accumulate $30 billion to eliminate them on a crash program. So we are calling upon the researchers and the technologists to come up with a new approach to the problem while recommending a standby partial solution—bar construction of combined sewers in urban renewal areas. Incidentally, in the Rochester area you had this enormous problem. It was relieved to some degree by the construction of impounding basins, retarding dams, to reduce flow at the time when the treatment plants could accommodate the excessive flow, but notwithstanding all that, the problems are still enormous and, of course, a city like Chicago would require over $2 billion to eliminate the problem, it would be impossible to get sufficient drainage catch basins; we could construct layers of gravity flow sufficiently to eradicate that problem. So in answer to your question, Mr. Vivian, the great economies that will be perfected in this, can be perfected by your committee of even encouraging research and development to reduce this $30 billion in research planning down to a nominal figure that can be dealt with by the combined efforts of industry, local governments, and the Federal effort.

Over the long term, however, we must raise our standards for treatment of waste waters of all kinds and if we are to do so we must evolve new and more effective waste treatment processes.

What is the point of removing organic materials from sewage and leaving minerals and other nutrients (such as phosphates, nitrates) in the effluent—to nourish growth of algae and other offensive organisms in receiving waters? We have been doing just part of this in our treatment job.

Then there is the problem created by industrial wastes some of which contain toxic materials dangerous to aquatic life and even to man. Other industrial wastes contain mineral substances which complicate the sewage treatment process when discharged into municipal sewage systems. Others contain large quantities of organic substances that deplete oxygen in receiving waters. Industry discharges huge volumes of heated water which raises the temperature of the receiving waters and thereby frequently destroy all but the hardiest of organisms.

In addition, there is the problem created by drainage of new synthetic pesticides and phosphate and nitrate fertilizers. Excessive sedimentation is still another major problem.

Let us not overlook the economic involvement in an accelerated pollution control and abatement program. This is an expensive program for all concerned. As efforts are expanded and water quality standards are made more stringent the program will become even more expensive.

I believe, then, that government at all levels and industry must now turn to the scientist, the researcher, the engineer to devise more effective and more economical methods of pollution control and abatement.

Research and development programs have contributed significantly to the national war on water pollution. But if we are to achieve a real breakthrough in this war, these programs must be substantially expanded without delay. Increased Federal support will be required and should be granted.

Mr. Chairman and members of the subcommittee, this problem we face today is real and it is earnest. It won't go away if we ignore it. We must come up with new, effective and economical processes of pollution control and abatement. Otherwise, we won't win this war to clean up the Nation's waters.

Your subcommittee is helping to fulfill a national need by focusing attention on the need for better technological approach for water pollution abatement. I am sure your hearings will help to evolve new solutions and to advance the national effort in dealing with the vast tasks of reducing the mounting level of environmental pollution.

Mr. DADDARIO. Thank you, Mr. Jones.

Mr. Roush?

Mr. ROUSH. That was a very fine statement, Mr. Chairman, and I think you very clearly summarized the problem. I can well recall my immediate response when I was informed by my chairman that this committee was going into the problem of pollution. I asked him the question; How many committees of this Congress are going to study the question of pollution? I was concerned that there would be an overlapping and a useless effort on the part of this committee. Do I gather from your statement, Mr. Jones, that you feel the undertaking by this committee can serve a useful purpose and that it will not necessarily duplicate the efforts of your committee?

Mr. JONES. I don't think so at all. And, as I said earlier, Mr. Roush, this is a much-wanted and desirable approach by this committee and certainly I don't sense that it will trespass upon the sovereignty or aims or objectives of any other committee of the House.

Mr. ROUSH. I have received several impressions over these last 2 or 3 years in working with your subcommittee. As we went through the country we were dealing with the means of physically handling waste in the larger cities and industrial areas of the country, of financing these problems and of administering the programs. We also dealt with the initiation of new buildings and with new means and new facilities for treatment of waste. But, I always came back with the thought that the basic need was to find new technological and scientific means of handling this problem. Do you have that same view?

Mr. JONES. Yes, I do. As Mr. Blatnik pointed out, the antiquated schemes that are now generally used throughout the country are so enormously expensive that it threatens the whole effort of reducing these pollution problems with increased population. So, to relieve the problem we must come up with cheaper schemes or methods of handling the problems that inevitably come up in pollution treatment works.

Mr. ROUSH. I would agree, and I believe our committee would agree that there certainly is a need for enhancement of the research program insofar as pollution is concerned whether it be of air, water, or ground. But, another impression I had in working with your committee was that there was a need for a greater exchange of scientific and technological information relating to the research which is being done by various agencies of the Government, by industry, and by the States and their universities and colleges throughout the country. Would you agree that there is a need for a systematic exchange of information which might make available this information to all researchers?

Mr. JONES. Well, we will miss our true aim if we don't bring into play and to consultation one with the other, the various research programs that are undertaken either by industry or by the local governments or at every stage of research. There should be this interchange and understanding to avoid duplications and excessive cost in research programs.

Mr. ROUSH. Another impression I had was that there was a need to assess or evaluate the effectiveness of our present programs as we prepare to finance them. Would you comment on that?

Mr. JONES. Would you state that again?

Mr. ROUSH. Yes. I had the impression that there is a need to assess the effectiveness of our present research programs and then relate that to the allocation of funds.

Mr. JONES. Yes.

Mr. ROUSH. In other words, I felt that in some areas we were perhaps spending too much money on an ineffective program while in another area we were not spending enough on a program which held greater promise. There has not been an effective evaluation of the programs we have underway insofar as research is concerned?

Mr. JONES. That's true. I think Mr. Blatnik, in answering Mr. Conable, went to the heart of that point, and that is, that given priorities, it is very difficult to do, but I can think of one set of circumstances. Take the acid mine drainage problem, which is an enormous problem. It has been under study since 1933. We don't have the solution to it now. The cost of dealing in that area alone would require billions of dollars, so I think there are other aspects of the prob-

lem that are more acute and more susceptible of dealing with and finding better results than that program.

Mr. ROUSH. That's all the time for me, Mr. Chairman. I don't want to take any more time.

Mr. DADDARIO. Following through on Mr. Roush's line of questioning, Mr. Jones, one of the keys to this whole problem as I understand it from both you and Mr. Blatnik is that we raise the priorities of this effort in relation to other programs. And, if we do raise the priorities, we will have a better understanding of what needs to be done and there will be a greater transfer of information and understanding of the problem.

Mr. JONES. Yes, and the accumulation of the information as to who is doing what.

Mr. DADDARIO. If we intensify our effort, it would help increase information transfer and public understanding.

Mr. JONES. Yes.

Mr. DADDARIO. Mr. Mosher?

Mr. MOSHER. Mr. Chairman, we have been talking about inadequate technology today. Mr. Jones, from your vast experience and study in this field, do you feel that we have inadequate political arrangements to do the job?

Mr. JONES. I'll give you an example. There is political inadequacies because the State of New York on your Commission is to give the municipality, the city of Rochester, for instance, notice that it wasn't given the chlorination for 16 hours a day. The city of New York did not give the city of Rochester a cease and desist for 16-hour operation, but should have been in operation 24 hours a day. Then it was disclosed that the State of New York, in failing to give that notice to the city of Rochester, yet cited the city of Rochester that they were in noncompliance with the State orders. So, I mean these are political problems, in that sense.

Mr. MOSHER. Let's talk about the Lake Erie area again, for a moment.

Very obviously, to do the job in Lake Erie will require mobilizing many political constituencies on a local, State, county, and international level. It seems to me there definitely is a need for greater interstate cooperation along with the help of the United States and the Canadian Governments.

Have you had any new insights as to political compacts, interstate compacts or arrangements that might be used here? Do you think there is a need for new ideas?

Mr. JONES. Well, I direct your examination to title I of the Flood Control Act of last year which set out the New England States, in particular, from the Potomac River north, as to make interchange of water from basin to basin. The only effective interstate compact in the United States of which the compacting States contribute any substantial amount of water is the Delaware Commission.

If we could develop and exchange a surplus streamflow in the northern part of the outreaches of the Potomac River and make that water deposit into the reservoir for the city of New York, then that would be a commendable approach. We are going to have to do that whether we like it or not, and it is expensive. But the streams peculiar to your

area are very small streams to commence with. They have a short distance of flow and consequently you must be very careful in committing yourself to the extensive use that is required in the streams in the New England area. So, that gave it an opportunity to make an exchange provided, of course, that one stream was not given an advantage in the area where the water is being withdrawn in the exchange.

Mr. MOSHER. Mr. Chairman, could I ask one more question?

Mr. DADDARIO. Yes.

Mr. MOSHER. You referred to appropriations over a 2-year period at the rate of $20 million per year for demonstration projects.

Did I understand you to suggest that there is a need to expand and accelerate that program?

Mr. JONES. Yes.

Mr. MOSHER. Did I understand Mr. Blatnik to say that some of this money is going begging—that there are few takers?

Mr. JONES. He is talking about a different program. He is not talking about the sewage mining demonstration program.

Mr. MOSHER. I thought Mr. Blatnik was talking about that.

Mr. BLATNIK. Mr. Chairman, I will check on that.

Mr. Jones is more up to date than I am, but as I recall as of 2 months ago I believe only about three or four applications were before this particular agency and the other agencies that work on grants to municipalities for the combined storm sewer demonstration projects, and only one was granted.

Mr. JONES. One was granted to the city of Milwaukee. The reason there was a delay in making those grants is, under the reorganization plan transferring the authority from HEW to the Department of the Interior, it required a time delay; so, therefore, administratively they couldn't have undertaken it at an earlier date anyhow.

Mr. MOSHER. So, you don't feel this money is going to go begging?

Mr. JONES. No, sir.

Mr. MOSHER. And, you feel that it warrants expansion?

Mr. JONES. Yes, sir.

Mr. DADDARIO. Mr. Waggonner?

Mr. WAGGONNER. Mr. Chairman, I want to thank my colleague from Alabama for highlighting the common interest in this area between Minnesota and Alabama and I doubt that any areas inbetween feel differently.

Mr. Jones has demonstrated through the years his profound interest and knowledge of the needs of pollution abatement. I want to comment on one phase of his testimony this morning which certainly speaks for itself, and that is, his stated desire and interest in bringing business into the picture to an extent greater than they participate today. I think he is exactly right, and I think this illustrates the point of concern which Mr. Roush expressed earlier. I think Mr. Roush's concern with the overlapping jurisdictions and duplication among the congressional committees is well placed, but in this particular instance I think he himself realizes that it is natural that a number of committees should have an interest in pollution abatement. And, certainly this does involve many different interests. The Public Works Committee naturally is involved. The Government Operations Committee which Mr. Jones represents this morning, is naturally

involved, and the Ways and Means Committee, represented by Mr. Vanik who is to appear next, is also involved. It would appear to me that if industry is to be involved to a greater extent than before in order to utilize their technology and ability to do something about pollution, we have to utilize the Ways and Means Committee to give these people something in the way of tax incentives to help accomplish our desired goals.

Mr. JONES. There has been several bills introduced, Mr. Waggonner, going to that point. The subcommittee of which Mr. Roush and I served on have issued a report very recently on the desirability of the Governors of the States to receive tax reduction incentives.

Mr. WAGGONNER. Thank you, Mr. Chairman.

Mr. DADDARIO. Mr. Conable?

Mr. CONABLE. Mr. Chairman, you mentioned the figure of $30 billion to eliminate joint sewage, and that it would cost the city of Rochester a half billion dollars to do that, and Chicago $2.3 billion. Is there a pattern in the country as to the areas which are particularly bad in this respect? Is it the Northeast generally because the cities are older?

Mr. JONES. In the older parts of the city, in the tremendous metropolitan areas of all, almost all of the cities in the eastern part of the United States.

Mr. CONABLE. Is there any part of the country that is creating new situations of this sort?

Mr. JONES. No; I referred to the report we made. The Urban Renewal Administration was to give a grant to the city of Cleveland for the construction of a joint sewage and drainage so we interceded and as a result of our contention, the Department will now not make any loans to any city or grants for that purpose. They must be separate.

Mr. CONABLE. Are there any pilot projects for the disposal of human waste other than those which use water as an agent?

Mr. JONES. Well, there's lot of thought being given.

Mr. ROUSH. You will recall the system used in Chicago where a burning process is employed. It is not a pilot project, but their actual means of disposal.

Mr. JONES. They have spent in the city of Chicago approximately $5 million on a process that they thought they could produce gases and thereby with the solid waste or sludge, burn the sludge all up and they wouldn't have the problem of sludge, because to accommodate the movement of sludge to the pits requires 80 cars a day to haul the sludge out and, of course, the city has to acquire additional land to deposit the sludge in a place where it wouldn't be odorous or offensive or a health hazard.

But, unfortunately that has not worked out. There's other thoughts being given, trying to divide the solid waste. And, in Germany they have attempted the same type of operation. The city of Milwaukee followed the pattern of Sheffield, England, in making a fertilizer—the common trade name is Millnite—with some degree of success, but none of them so far have reached the expectations of the originators.

Mr. DADDARIO. Mr. Brown?

Mr. BROWN. No questions.

Mr. DADDARIO. Mr. Vivian?

Mr. VIVIAN. I have several questions.

I mentioned earlier the possible use in cities of multiple water distribution networks, one say very pure water, and a second say ocean water. The ocean water could be used for cooling air conditioners and flushing wastes. Has this proved to be economic?

Mr. JONES. No; it is too expensive to build separate distribution systems and to reduce the type of water you refer to in your question of Mr. Blatnik, say in the New York area. You can't locate a sufficient quantity of brackish water or water with a low salt content to make it inexpensive to operate. I have seen statements to the effect that it could be done, but I can't for the life of me conceive of the most advanced type of operation such as we have in North Carolina and Texas could be located in the New York area with the high power costs that New York has, that a cost structure would justify that.

Mr. VIVIAN. Some manufacturers object to the use of saline water for cooling purposes or flushing purposes because the pipes and tubes used in their plants or air conditioners would erode very quickly. Conceivably new technology could provide protection against erosion and save some of that cost.

Mr. JONES. Well, that's one of the problems that you create rather than resolve by getting a multiple type of operation. Where the savings are going to come about is to get combined systems and to make those combined systems both in the pollution and the distribution of water through an area development type program.

Mr. VIVIAN. I would like to relate an example of the problem of combined sewage overflows that you just mentioned. Detroit has this problem. On days when the rain comes down heavily for a short period of time, the total Detroit sewage treatment plant is effectively put out of operation by the great flow of water through the plant, and the sewage from the city goes right into the river.

Mr. JONES. They built that to take care of 2⅓ of the normal streamflow of the expected capacity in the year 1912.

Now, when you build all these parking lots, these apartment buildings, and pave all the streets and sidewalks, then you get about six or seven times the amount of water which were constructed to accommodate that.

Mr. VIVIAN. I would like to remind the committee of a fact, Mr. Jones, that you well know, that this overflow problem doesn't bother Detroit very much because the overflow goes right down the river away from the city. However, it does bother my constituents, for the overflow ends up off my district shortly after.

To turn to another question, I wanted to point out that costs of many types can be saved by even moderate improvements of pollution treatment systems. In my district, the Corps of Engineers is considering proposing damming up of the headwaters of one of the rivers to provide a water storage reservoir to control waterflow in the river, to maintain a high waterflow in the fall as well as the spring. The sewage treatment plants now along the river release sufficient effluent to cause troublesome pollution in the fall, during low waterflow, though not in the spring.

Now, if we could raise the efficiency of those sewage treatment plants from say 92 percent to 96 percent, we might not have to build

the very large storage reservoir facilities, which inundate a very large amount of land.

Mr. JONES. I don't think you are going to get any kind of system, secondary, primary, or otherwise, that will get better than 95 percent.

Mr. VIVIAN. You feel there is no hope of going in that direction?

Mr. JONES. At the present time one of the purposes of this hearing today is to try to find out how we can get a hundred percent efficiency because these waters—for instance, take Cincinnati, Ohio. In the low-flow period where you normally accommodate 200,000 cubic feet per second, the water is being used as much as six times, so you are going to have to have these treatment plants, both in the heavy industrial section of the Ohio River, the Monongahela, and the streams in the West Virginia area which has its confluence below on the Ohio, as to have a general pattern of stream abatement not only to make water available for use six times, but as much as nine times as you have in the Connecticut River.

Mr. VIVIAN. The State of Michigan recently passed a tax benefit for firms that install pollution abatement equipment. I wonder if there is any uniformity of action on this approach across the country.

Mr. JONES. No.

Mr. VIVIAN. Has any model law been suggested or recommended?

Mr. JONES. No. The only study I know is made by our subcommittee of Government Operations which I discussed with Mr. Waggonner earlier. I will be glad to make available to you—and they have had wide distribution—but I don't think there is a general consensus of the Governors of the respective States how to go about it.

Nor is there a demand of industry generally that I know anything about for such an arrangement.

The industrial groups that came before our subcommittee last week and the Committee of Public Works did not seek that approach.

Mr. DADDARIO. Mr. Ryan?

Mr. RYAN. Mr. Chairman, I simply would like to thank Congressman Jones for joining us this morning and sharing his vast knowledge of this subject with us. I'm sure the subcommittee will certainly benefit by your views and the expression of them this morning, Mr. Jones. I think you have shown us, as you have demonstrated in your service in Congress, that you have a great national outlook on this problem. I think this is one of the great assets which you bring to the Congress, and which is reflected in the work of your subcommittee.

I was interested in your statement about the failure of the State of New York to provide advance notice to the city of Rochester. Could you elaborate on that? Was it made in a report of the Monroe County Grand Jury in December of 1965, which was reporting on the pollution investigation?

Mr. JONES. Yes.

Mr. RYAN. Well, we will follow it up from there.

Mr. DADDARIO. Mr. Jones, I want to thank you.

Mr. JONES. I would like to add one thought, Mr. Chairman. The question that has been discussed about Lake Erie and its enormous problem. Of course, Lake Erie has more natural pollution than any of the other lakes. The suggestion of those who advocate the expenditures of some billion dollars for dredging, bar removals, and to cor-

rect the natural contaminants, I think real thought is going to have to be given to that. Since it is an international lake and body of water, considerable thought should be given to the acquiring the amount of water now flowing into Hudson Bay and St. James River. You have approximately 400,000 cubic feet per second. It flows in an area that is uninhabited. It is of no use to the area into which it flows. It has hydro potential that could supply enough hydro to provide pumping stations to make sizable discharges in the Great Lakes which would, in the thoughts of some of the experts, remedy the Lake Erie situation more than any other scheme that could be employed, and I think it is worthwhile.

Mr. VIVIAN. I am glad that your committee is interested in studying this subject and encouraging action on it. I hope you will include the study of what are known as the Grand and NAWAPA plans.

Mr. JONES. That aspect of the problem will be studied.

Mr. DADDARIO. Mr. Jones, thank you.

Mr. JONES. Mr. Chairman, I thank you for the opportunity of visiting you today.

Mr. DADDARIO. This has been an excellent contribution and we are grateful to you.

Our next witness is Congressman Charles A. Vanik of Ohio.

Mr. Vanik is a distinguished member of the Ways and Means Committee and he comes from the same State as Mr. Mosher, although they happen to be in opposite camps.

STATEMENT OF CONGRESSMAN CHARLES A. VANIK, COMMITTEE ON WAYS AND MEANS

Mr. VANIK. Mr. Chairman, first of all I want to take this opportunity for thanking your committee for its great interest and grave concern on air and water pollution abatement and technology. Your inquiry into the technology of pollution abatement rounds out the spectrum of what should be the Federal interest in the total problem of water pollution and air pollution.

I am, of course, gratified with the progress of the water pollution control legislation under the leadership of my distinguished colleague, Congressman John A. Blatnik, chairman of the Subcommittee on Rivers and Harbors, Committee on Public Works. The work of the Subcommittee on Natural Resources and Power of the Government Operations Committee, headed by my distinguished colleague, the Honorable Robert E. Jones, has made a very valuable contribution in focusing attention on the failure of the Federal Government to utilize its vast powers of regulation to bring about effective pollution control. My distinguished colleague, Hon. John D. Dingell, as chairman of the Subcommittee on Fisheries and Wildlife Conservation, has focused national attention on the destruction of our vital fish and wildlife resources through the damage of water pollution.

Now, while all of these efforts are contributing immeasurably to the solution of the water and air pollution problem, I join those who fear that the gap in pollution abatement technology constitutes one of the most critical problems confronting our Nation. While we have made astonishingly technological gains in all fields, it seems as though we

have made only minute, token advances in the technology of water pollution control and air pollution control.

I live in a community which faces the problems of water pollution and air pollution in almost incredible concentrations. You have many times heard of the progressive deterioration of Lake Erie which is rapidly becoming a useless, dead water sea. Probably no city in America faces so critical a problem of air pollution as does Cleveland, where the steel and petrochemical industries generate life and property destroying pollution in a valley situated right in the heart of the city. The smokestacks which pour the polluted gases rise above the valley so that they pour their affluents at almost the same altitude as the adjoining residential area.

Year after year during the past 30 years of my recollection on this subject, there have been promises after promises that the next year would be better. That the pollution of the lake would somehow be curtailed and that new devices would be controlling the pollution of the air. Three decades of fraud on this subject have almost convinced our people that relief will probably never come.

Those who can afford it move away from the pollution of the air. Those who can afford it utilize other waters than Lake Erie for recreation. Those who cannot afford it remain trapped in an atmosphere of polluted air along the shores of the lake which will soon have no more utilitarian value than providing a sunset view in the early summer.

The pollution of the water of Lake Erie is chargeable to ineffective or absence of water treatment by industrial users and to inadequate and sometimes absence of treatment on the part of public users. The pollution damage to our waters is therefore divisible; the responsibility for pollution of our air, except for motor vehicle emission, is not divisible. The muriatic acid which etches the windows of Cleveland homes can only have its origin in the steelmaking process. The graphite dust which settles over vast residential areas during the quiet of the night can only come from industries which push it into the atmosphere under great pressure. The yellow iron oxide dust which blankets large areas of the city with certain changes of the wind can only have its origin from industrial operations.

The present programs of water pollution control will be helpful but will not provide the critical solutions to the water pollution problems of Lake Erie and the Great Lakes.

The technology of water pollution control by industry in the Ohio River Valley and the other great river valleys of America is vastly and critically different from the crude and elementary technological processes in water pollution control utilized on the Great Lakes. The downstream users of the Ohio Valley would not countenance for 1 hour the affluents of the steelmaking industry on Lake Erie and Lake Michigan. As a matter of fact, until very recently there were practically no efforts to clear up industrial waste water in the Great Lakes Basin.

If we were to compare the steelmaking industry in the Great Lakes areas with the comparable steel industries in the Mahoning and Ohio River Valley, we would find that the Great Lakes steelmaking industries do not utilize any visible devices for the removal of mill scale, oil and grease, and that the Great Lakes steelmaking industries pro-

vide practically no treatment of spent pickling solutions and rinse water developed in the steelmaking process. The steel industries almost universally use these processes for water pollution control except where the steel industry is located on the Great Lakes or on the waters of rivers or bays that flow directly into the ocean.

It is my hope that somehow or another Federal interest would center upon the technology of controlling industrial pollution of the air and of the water. For example, a steel mill wherever situated uses water in much the same way and discharges substantially the same kind of pollution into the air. Therefore, the treatment of water after use by a steel mill and the control of the pollution of the air by a steel mill should be substantially the same whatever the water source and wherever a steel mill is situated. The same principle could be applied to various petrochemical industries. Standards for the abatement of air pollution and for the industrial use of water on an industry-by-industry basis would create a uniform, nationwide approach to the problem.

No other industry in any particular place would be singled out for overhead expenses in air and water pollution control, not undertaken or experienced by its competitor. With the utilization of the same technology, no one plant would have a competitive advantage over its counterpart in the same industry with respect to pollution control devices.

There are astonishingly different methods utilized for the treatment of water in the steel industry.

For example, there are different approaches to the treatment of the so-called pickle liquors which are discharged in the steelmaking process.

The Inland Steel Corp. of East Chicago, Ind., proposes to solve this problem by draining off the spent acids into a 4,300-foot-deep well designed to dispose of 432,000 gallons per day of pickle liquors, the prime pollutant in the steel manufacturing process.

On completion of the well, waste acids will be pumped into a 1,880-foot-thick stratum of porous sandstone called the Eau Clair and Mount Simon formations. Initially, 115,000 gallons a day, about 95 percent of the total now generated, will flow down the well. The balance will be used in the plant for other purposes.

The Armco Steel Co. at its Ashland, Ky., plant utilizes giant clarifiers to remove mill scale and employs a hydrochloric acid regeneration plant to eliminate spent pickling solutions into the Ohio River.

At Butler, Pa., the Armco Steel Co. treats all pickle liquor with lime to make an iron hydroxide solution which is pumped into settling lagoons for permanent storage.

In Cleveland, the Republic Steel Corp. plans the disposal of pickle liquor through the installation of a regeneration plant which would permit the reclamation and reuse of the spent acid.

There is also a process known as the Du Pont process in which the waste sulfuric pickle liquor is neutralized with lime to produce magnetic iron oxide, gypsum particles, and neutral water. Both of the resulting solid materials may have byproduct value or, at least, can be used for land fill. This is reported to be a reliable continuous process designed to operate in low-cost steel equipment with minimum operator attention.

And, it has just come to my attention that in Japan, the Kawasaki Steel Corp. of Tokyo has successfully completed another process aimed at economically meeting the problem of discharged pickling liquor from rolling mills.

The Kawasaki process neutralizes the wastes by ammonia gas and converts them into marketable byproducts of ammonium sulphate and magnetite iron oxide.

The shocking fact is that no responsible Federal authority is currently evaluating the efficiency of any of these alternate methods to determine whether they meet acceptable standards. In the case of the Republic Steel Corp. of my city we will have to wait until 1969 before the plant is in operation.

Under these circumstances, the various steel producers are following different procedures in the treatment of pickle liquor developed in the steelmaking process. Certainly one of these processes is superior to the others, providing higher quality water after treatment. It is very likely one or more of these treatment methods is completely inadequate and highly inefficient, returning semitreated water to our water systems. Is it prudent to permit the construction of costly systems by private industry which may prove unsatisfactory?

It seems to me that authority should be vested with an appropriate staff in the Division of Air Pollution, Department of Health, Education, and Welfare, to study the various procedures for the abatement of air pollution for each specific industry and distinguish between those which are acceptable and those which are not.

It seems to me that authority should be vested with an appropriate staff in the Division of Water Pollution Control of the Interior Department to study the various treatment procedures for each specific industry and recommend which are acceptable and which are not.

The State and local communities are completely unequipped to make such a determination. These industries engage in interstate commerce and fall clearly within the spectrum of Federal study and determination.

In order to bring relief to the industrial communities of America which live under almost intolerable conditions of water and air pollution, I hope that the technology for pollution abatement can be dramatically accelerated. In this connection, I will strive, as a member of the House Ways and Means Committee, to bring about tax incentives for the development of proper pollution control devices and procedures. As a matter of fact, accelerated depreciation for the construction of air and water pollution control devices should be contingent upon the approval by either the Water Pollution Control Division of the Department of the Interior or the Air Pollution Control Division of the Department of Health, Education, and Welfare. The tax writeoff should be granted only in those cases where a certificate of approval has been obtained to insure that the pollution control device will meet the requirements of the situation and that the extent of the expenditures designated for accelerated depreciation will be limited to that portion of the expense to industries which are directed toward the control of pollution.

As long as the possibility of accelerated depreciation remains unsolved, my fear is that the industries will put off making large-scale

expenditures, which are necessary. For these reasons, I am urging my committee to proceed into immediate hearings on this issue and either decide the question one way or another, either indicate that it is something we can consider this year or something that we can consider next year or provide at least a promise that any legislation that can be drafted might have a retroactive effect so that it can urge and certainly stimulate industry to move forward at once.

The Treasury effect, resulting from pollution control accelerated depreciation credits, would not be substantial for at least several years. But, the legislation would spearhead a pollution control program not otherwise probable.

In the meanwhile, it is my hope that your committee will provide some effective machinery to develop and to judge air and water pollution control devices and procedures on a sound basis so that our Nation can overcome the critically technological gap in the science of waste control.

Mr. DADDARIO. Mr. Vanik, that is an excellent statement. I'm encouraged by the testimony given by Members of Congress who have appeared here today because it shows, without question, that people on important committees have a great deal of concern, have put their minds to the problem and have many suggestions as to what needs to be done. You have recognized that higher priorities must be developed, and the fact that you are taking such a leadership in the Ways and Means Committee so that there can be these incentives is extremely important.

We have not had an opportunity to study, in great detail, such tax credits or incentives and their effects in other countries, but Canada has a particularly good system in which they give a tax credit when increased activity in pollution abatement can be shown over the years. Industries are given credits for any increases and this stimulant is extremely helpful. There is no question that this kind of legislation acts as an incentive to industry to increase its activity in the field of pollution abatement.

Your idea of giving each industry special consideration so that they can be understood and so that one industry does not have a competitive advantage over another is something that is certainly worth looking into, and I commend you for having given so much thought to this important aspect of pollution. It is very helpful.

Mr. Mosher?

Mr. MOSHER. Mr. Chairman, my Ohio colleague is very articulate. I expected from him a very stimulating and provocative statement, and that's what we got. I congratulate him.

Mr. VANIK. I think you have a bill, don't you have a tax credit bill in the file?

Mr. MOSHER. I hope that one of the important results of these hearings will be to demonstrate the advisability of Federal tax incentives such as you suggest. I hope that the hearings in this committee will provide an even stronger basis for the fight you are making, and expect to make in your committee for that type of legislation.

Mr. ROUSH. I have no questions.

Mr. DADDARIO. Mr. Vivian?

Mr. VIVIAN. Mr. Vanik, I was particularly interested in your comments proposing industry by industry effluent standards. I think it

is quite important that the standards be set industry by industry for the following reasons. We have in my district in the city of Monroe, bordering on Lake Erie a number of papermills. Second after second, they pour volumes of what can best be labeled as "goop" into the local waters which flow into the lake. The papermills do have facilities for cleaning the effluent from the mills. Now when the officials of the mills know I'm about to visit, these facilities are always operating. But when I visit unannounced, they're shut off. Now I have talked at length with Public Health officials in the area. They tell me that they are reluctant to enforce the codes affecting these mills be cause they are afraid the mills will move from the area and relocate in some other location, such as some location bordering the ocean, or in some other State where the laws will not be enforced. The net result is, nothing happens. And Lake Erie continues to be filled up with more of this goop.

If nationwide industry-by-industry standards existed, there would be less incentive for papermills to move to other places, and there will be more reason for them to install better treatment equipment, and to operate it without lapse.

Fortunately there is a distinct change in attitude in these industries in the last few years.

The industries themselves are attempting to improve their ways. Tax incentives tied to performance could increase their pace.

Mr. VANIK. I might say the paper industry is running, I saw, down at the Gulf of Mexico, a once-beautiful beach area that is now polluted.

Mr. VIVIAN. You indicated that the steelmills anticipate pumping pickling acid waste into a thick stratum of porous sandstone.

Mr. VANIK. That process has been indicated by a producer in Indiana.

Mr. VIVIAN. Doesn't that create large holes in the ground?

Mr. VANIK. I might give you one sentence and I have this from their announcement. They are going to pump 4,300 feet down into a strata of limestone and it is going to be able to take 115,000 gallons a day and as the affluent pickle liquor pours into the limestone, it develops a chemical reaction with the alkali and limestone and becomes neutralized and spent, and this bit of strata of limestone has the capacity to apparently treat the affluent so that it can continuously be poured in.

Mr. VIVIAN. Doesn't the subsurface rock structure become weakened physically? Can't it collapse like coal mine overburden occasionally does?

Mr. VANIK. Well, it comes into strata of open areas. Limestone has caverns and open areas in it but what we are doing is pouring the affluent into open areas of strata of limestones. It was said that the same process would be workable in the Cleveland area. We have the same limestone formations below Cleveland, but our industry is going to use what they call the hydrochloric acid regeneration system. They say this works at Gadsden and they say that it works very successfully there, but I don't know whether this will take care of the total problem or not. This is one of the questions I raise. I feel that as you do, we should have some research on these matters to determine

which process is going to be the one we will accept and which processes are going to do the job properly and adequately.

Mr. DADDARIO. The question of disposal of waste materials in deep wells deserves a great deal of attention. As you have said, Mr. Vanik, it apparently will work but nobody is really sure.

In developing a base of investigation, we have become familiar with this particular method of disposal, but we need to know more about it and come to some decision as to whether or not it will be effective.

Mr. VANIK. There is one thing about it. Whatever it does, it puts the affluent away, which maybe if it can be safely put away from humanity and from contaminating other sources of water, it is certainly superior to systems that are not efficient. They say it seals off the well, so there is no flow in or out and it becomes a sealed area.

Inland Co. is the company doing this at East Chicago, and I think we ought to watch it very carefully.

Mr. DADDARIO. Mr. Ryan?

Mr. RYAN. I really want to commend our colleague, Mr. Vanik, for a very fine statement, and I agree that industry should play an important role in pollution abatement, and I think a tax incentive will go a long way toward solving this problem.

Mr. DADDARIO. Thank you.

Our hearings tomorrow will hear testimony from representatives of the Department of Health, Education, and Welfare. The witnesses will be Mr. Wilbur Cohen, Undersecretary; Mr. Arthur C. Stern, Assistant Chief, Division of Air Pollution, and Dr. Wesley E. Gilbertson, Chief, Division of Environmental Engineering and Food Protection.

This committee will adjourn until tomorrow morning at 10 o'clock at this same place.

(Whereupon, at 12:05 p.m. the committee adjourned until 10 a.m., Thursday, July 20, 1966.)

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THE ADEQUACY OF TECHNOLOGY FOR POLLUTION ABATEMENT

THURSDAY, JULY 21, 1966

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT,
Washington, D.C.

The committee met, pursuant to adjournment, at 10:08 a.m., in room 2325, Rayburn House Office Building, Washington, D.C., Hon. Emilio Q. Daddario (chairman of the subcommittee), presiding.

Mr. DADDARIO. This meeting will come to order.

We are pleased this morning that our witnesses represent the Department of Health, Education, and Welfare.

Secretary Wilbur Cohen, Mr. Stern, and Mr. Gilbertson. We are happy to have you here, gentlemen. Having set forth the ideas of this committee's objectives yesterday, I need not repeat them today. You have been in touch with our staff and know what the purpose of these meetings are, so we can just continue.

I understand, Mr. Secretary, that you have another engagement later in the morning.

Mr. COHEN. I might say it has to do with nursing homes and I have a lot of Members of Congress that seem to be interested in that aspect.

Mr. DADDARIO. Proceed.

STATEMENT OF MR. WILBUR J. COHEN, UNDER SECRETARY, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Mr. COHEN. Mr. Chairman, I thought it would be best if I put my statement in the record and attached to it I am submitting for your consideration a document which the staff has prepared on the health hazards of community air pollution. I will then summarize just briefly for you a few points that I think are the highlights of my testimony if that is agreeable with you.

Mr. DADDARIO. Yes, please.

Mr. COHEN. In my testimony I bring out the important economic facts that the best estimates indicate that the annual economic losses resulting from uncontrolled air pollution are estimated to be in the neighborhood of about $11 billion. This is a very high cost and we think that it indicates the need from an economic standpoint to do something about this important problem.

To me, in addition to the arguments about how air pollution interferes with visibility and imperils air and highway transportation and pollutes soils and corrodes buildings and damages clothing and home furnishings, one of the most pointed arguments about the effects of

pollution is that some of the buildings like the Parthenon and some of the monuments like Cleopatra's Needle have stood thousands of years in dry climates, but when they are brought into any polluted atmosphere, the corrosion in 50 years is more than has occurred by natural elements in thousands of years. This is just an indication of the accumulation of pollution that is occurring which is going to have tragic consequences for health and for our economic conditions and our general state of the quality of our civilization.

I also point out on page 6 of my statement something which I'm sure all of you realize, and yet which succinctly summarizes the problem with which we are faced; and that is, the amount of air available for our use remains constant and there is no way to increase it. The only sensible recourse is to control the sources of pollution.

Mr. DADDARIO. Mr. Secretary, yesterday in my opening remarks I pointed out that in Connecticut our most valuable agricultural cash crop is tobacco. The agricultural experiment station in Connecticut has had to develop a new strain of tobacco to resist the damage of ozone. This points out, in a different way, the problems caused by an increase in atmospheric pollution.

The damage done to buildings, of course, is one question of concern for the committee. We have no real information about the effect that air pollution can have not only on plant and animal life, but on human life too. The cumulative effect of this particular trend is also unclear and I'm pleased that you point out this problem in such a forceful way here this morning.

Mr. COHEN. If you will refer to page 10 in my testimony where I take up the problem of motor vehicle pollution, I point out there that motor vehicle pollution affects more people across the entire country than does any other single element in the total air pollution problem and it is both national in scope and growing in magnitude, and the impact of this upon agriculture and farming is frequently overlooked. It causes very widespread damage to farming and vegetation.

In the State of New Jersey in a recent year 38 vegetable, ornamental, grain, and fruit crops suffered damage; every county in the State was affected. In California, photochemical smog has made it impossible to raise crops in many areas where such activity was once profitable. Nationally, as long ago as 1962, evidence of damage to plants and material from motor vehicle pollution had been observed in parts of 27 States. I think we are making some progress in this direction, but I don't think the economic impact to farm production and farmers can be overemphasized in terms of the effect air pollution has in that area.

Mr. DADDARIO. And, it is difficult to keep pace because you have shown that some areas of California cannot grow crops that were once profitable. Even though one can develop strains that can resist pollution, the air becomes so polluted that even these are not immune. They are only immune to a certain level of pollution.

Mr. COHEN. I would like to turn briefly now, after counting some of these problems in my testimony, to what we in the Department believe are the goals for action, that are necessary for us to make in order to continue these major new attacks on air pollution.

In developing our staffing, and our budget and our programing for the next few years—and this is important because I think we have

a long-range problem here, we have to look at what we are going to do during the next decade or two, we have set a certain number of goals, and I would like to go over them briefly with you starting on page 12.

The first such goal is a 25-percent reduction in air pollution from industrial and munipical sources by 1975, and this applies primarily to manufacturing and processing activities and to such municipal activities as burning and incineration of refuse. I might say I have always felt strongly about this having lived in Ann Arbor, Congressman Vivian's district, and going to Willow Run Airport where the dump was always burning the refuse and you had to pass that twice a day. It was a concern always to me that this kind of pollution was allowed to continue to exist and I think we could make serious inroads in connection with this kind of problem.

To accomplish this goal there must be a substantial expansion of the State and local efforts and also of research and development activities both by government and industry. The Federal Government will clearly have to provide leadership and assistance in both of these areas.

I would like to point out to the Members of the House that Senate bill 3112 which has just recently been passed by the Senate will be coming up for House consideration, will enable us to take a few further steps toward meeting this vital responsibility. This bill which you will be considering would authorize grants to State and local governments to assist them in maintaining effective control programs. This would be in addition to our present authority to award grants to create new programs or to improve existing programs.

The proposed new activity will enable the Department of Health, Education, and Welfare to help State and local governments meet the need for sustained long-range efforts to deal with their air pollution problems.

In addition, the bill proposes needed increases in authorized appropriations for our air pollution activities for the current and the next 2 fiscal years.

I might say the various successive enactments by Congress since 1955 have helped to strengthen State and local activity. A lot has been done, but I think we must do a great deal more to help the States and localities deal with the problems that are within their purview.

I think this means helping them to train and retain adequate staff, to undertake more effective regulatory activities, to help develop standards and to take leadership. I believe the Federal Government has a very important role in all of these activities, but without the full cooperation of the States and localities we will never be successful.

Mr. DADDARIO. Referring to your concern about personnel, you said the States needed help in training and retaining adequate staff. What kind of shape are we in from that point of view at the moment? How big a challenge is that?

Mr. COHEN. I think we have only just begun to undertake the work in the training of personnel. I think a very large restraint on expansion of present activities is that personnel is limited in this field and in this area I think of the Federal Government as having a major role in providing training funds to the universities to help train personnel. But then unless the States and localities are willing to take these peo-

ple on their budgets and pay them adequate salaries, of course the people are not going to stay in the places where they are needed.

Now, I might say, Mr. Chairman, this is a problem that we face in almost every single activity. I am now generalizing beyond air pollution, beyond water pollution, nursing, nursing homes, hospitals—you take anything that we touch in the Department of Health, Education, and Welfare that involves a new program, we find a tremendous shortage of personnel. The need for training and adequate salaries and then retention by the States and localities, I think is almost a No. 1 problem in developing a program and getting the program more effectively implemented throughout the country.

Mr. DADDARIO. I would agree that that's so. I think that we have to give due attention to our national problems and this is certainly one of the greatest problems which exists. It comes to mind that over the course of time we have developed a rapport between the Congress and the scientific community. I think the Congress will continue to appropriate research and development funds and I think that these can be increased to meet such important challenges.

I wonder if there should not be some kind of stimulus within the scientific and technological community to meet this challenge. What do we do to incite activity in this area?

Mr. COHEN. Well, I wouldn't pretend to know the whole answer. My first reaction to you is, first the great universities of the country must in their schools of public health, in their engineering faculties, in their sciences generally, begin to recognize these whole areas of environmental pollution as an important aspect of university training and development.

From the Federal Government standpoint I think we will need to help them develop their staff and to train people and out of this will come both the people who will be doing the control work and I hope some of the scientists who will be helping in technological development and scientific improvement which are necessary in this area.

On the other hand, I think the relationship with industry is extremely important and I would hope that both the Federal Government as well as the universities could work jointly together—the Federal Government, universities, and industries in common attack on this kind of a problem.

Mr. DADDARIO. An article in this morning's New York Times was called to my attention. The article says that the Delaware River is to get a cleaning, and although it refers to water, you can draw an analogy to the air problem. It states that the cost of cleaning up this river will involve many millions of dollars. The article acknowledges that this costly project would require use of waste treatment processes that are now of questionable technological value.

The analogy is, that in the area of air pollution control, we are also using questionable technological means to meet the challenge. This fits in with your manpower situation. There is a need for people to do the research which will bring the cost down so that we can have an effective program.

Mr. COHEN. I think until the American people are galvanized into recognizing that the problems of environmental pollution are going to possibly engulf our children and our grandchildren if not ourselves

before a few years, they are not going to be willing to invest, and I use the word "invest" advisedly, substantial sums of money that will be necessary in the allocation of scarce manpower resources in a concerted nationwide attack on this problem. I think there is a great deal of public recognition; more than many people recognize, but I still think it is also necessary to bring to the attention of the American people the serious consequences of this before we can really get them to feel that the tremendous economic and social cost of pollution can at least partially be offset if we undertake a vigorous program now.

Mr. DADDARIO. There's no question in your mind but that the studies made today show that the consequences will be serious.

Mr. COHEN. Very serious.

Mr. DADDARIO. This is just not a guess?

Mr. COHEN. This is not a guess. When you read our report that we are submitting for the record on health implications of pollution, I think the impact of some of those on diseases and disability is just devastating and it is terrible calamity to think that children and people are going to be adversely affected in their health by the pollutants now going into the air and water.

Mr. DADDARIO. Mr. Roush?

Mr. ROUSH. I think I take issue with Mr. Cohen when he says we must perpare the American people for the cost of such a program. I believe the American people are now prepared to meet the cost of such a program. I'm a practical politician and I find no resentment among the people of my constituency who are conservative about spending money on our water pollution problems and our air pollution problems.

I think we have arrived at this point, and although I have comments and questions which I would like to make later, I feel that now our problem is to put the proper tools in the hands of our administrators so that they can use those tools in solving those problems.

That's all.

Mr. DADDARIO. I think that's what Dr. Cohen has in mind. I don't see anything in your statement which disagrees with what Mr. Roush has just said.

Mr. COHEN. I am not only agreeing with him, but I am delighted to hear him make the statement and I think in many parts of the country public opinion is way ahead, way ahead of what we are now doing and willing to do, and I just hope that as a result of this we can go ahead faster. As you say, a large part of it is giving the people the tools with which to work.

Mr. ROUSH. Maybe I misunderstood Mr. Cohen, but I thought he was saying he considered the biggest task now to be that of preparing people psychologically so that they would be prepared to make the necessary expenditures to meet this problem, and that this was a job that had to be done in the universities, colleges, and in the local communities. I think that is behind us, and that the thrust of our efforts should be more practical now.

Mr. COHEN. Well, I must say that while I agree with you, I always find that when I come before the appropriating committees, I find a little bit more difficulty than I find when I go out in the country. I don't mean to imply that the appropriating committees have not been generous with us in helping us to finance these programs, but I do

think that there is a problem in training this manpower and in putting the money into the scientific development. Scientific development and the roles of the universities, all need further push, vigorous push if we are to get to these goals that I am describing.

Mr. DADDARIO. There are certain areas of pollution which have not, as yet, been studied fully. You would not be able to come before the Congress and ask for funds for these because you wouldn't know what to do with it.

Mr. COHEN. That is correct. And, there is another aspect, of course, if you said to me we are going to give you all the money you want, it would still take a good deal of time not only to develop the various aspects but to train the manpower and develop the programs. It is just a matter of forward motion, and that's why I'm urging that we set our goals sufficiently ahead of time to see if we can work toward them more effectively than we are doing at the present time.

Mr. DADDARIO. Mr. Conable?

Mr. CONABLE. I simply want to underscore this conservatism further. I represent a constituency that is conservative and most of my people don't think we are spending enough on air and water pollution. But I feel we have to hang back at this point because we are not ready to make the investment intelligently. In these hearings, we don't have to discuss the question of need. I have the impression that the Congress is quite willing to be shown the way by the experts. The purpose of these hearings is to find out what the experts can tell us about where funds would be best invested.

Mr. COHEN. Well, we have two of our best experts here today that will go into that with you, and I would just like to finish the three goals that I think are important.

Our second goal, which I have enumerated on page 13, concerns sulfur oxide pollution from the burning of fossil fuels, primarily at such large installations as powerplants. This is one of the most important air pollution problems for which control technology is still deficient; however, several promising approaches have been developed and are ready for full-scale testing.

Our goal is to demonstrate the feasibility of such techniques by 1970. But, because sulfur oxide pollution is already a serious problem in many large urban areas, it is essential that interim measures be adopted to keep the problem from worsening. In brief, such measures involve greater consideration of air pollution problems in decisions on the allocation and use of fuels. We are already trying to encourage greater use of low-sulfur fuels in areas where the sulfur oxide pollution is now serious.

In addition, serious consideration must be given to modifying our national fuel import policies in order to give priority to low-sulfur fuels and to locating major new fuel-burning installations, primarily powerplants, outside urban areas.

The third goal concerns motor vehicle pollution, which I have already discussed. Our objective here is a 25-percent reduction in this problem by 1975 and a 40-percent reduction by 1985. In our view these goals can be achieved by improvement in control technology applicable to the internal combustion engine, but even the most effective technology we can envision will not be adequate to keep this problem

from worsening in the face of projected future increases in our use of motor vehicles. More than 85 million motor vehicles are now in use in the United States, and this number increases every year. It is estimated there will be, if it is possible to get them on the road, some 120 million vehicles in use by 1980.

Mr. Chairman, I think that very briefly summarizes some of the main points in my testimony, and I will be glad to answer any other questions that you have.

Mr. DADDARIO. Mr. Secretary, on page 13 of your statement, in the last sentence of the first paragraph, you say:

> A sound regulatory program with uniform legal requirements to insure equality of treatment among competing industries is an effective stimulus which encourages industry efforts to improve and apply control technology.

I wonder about that. My question is, will this work or might it not force hasty installation of technically inadequate equipment? Don't we need to institute some kind of Federal support for R. & D. or incentives so that we can develop the necessary techniques before we apply the regulations?

Yesterday Mr. Vivian made the point that when he visited a pulp plant in his area and the people knew he was coming, the pollution abatement apparatus was working. When he made an unannounced visit, it was not working. Obviously, the reason is that it is expensive to run and they were trying to avoid the cost. They have not yet found a technique which can properly fit the situation.

Could you touch on that a bit?

Mr. COHEN. Well, I would say in our Department our thought is one shouldn't take one aspect of what can be done and only do that. We should have a well-rounded program in the whole field that would consist of the research and development aspect of the program which should be encouraged vigorously, and also the element of the training of personnel, cooperative work with the universities and industry, work with the States; and then I think the point that perhaps you are touching on in addition to that is effective compliance.

I think that we have a problem here that is vast in its dimensions. You pointed out quite well there are many unknowns. I am sure there will be a lot of changes in technology as it goes on. Many of these things are very costly and I think that what our goal is, is to develop a program on quite a number of fronts at the same time. One should not be done to the exclusion of the other.

Mr. DADDARIO. Do you think there should be some degree of flexibility in administering these legal requirements?

Mr. COHEN. Yes; I think you have to be very sensible. You do have criteria and you do have standards and you do have a regulatory approach to it. You can't expect to have everybody come into compliance overnight.

I think you have to use good sense in your timing and the rapidity with which you achieve your objective, and also I think, although I am not an expert in this field, but in the field that I do know something about, I know that you constantly must be on guard not to assume that the science and technology of today is going to be the science and technology of tomorrow.

You have to realize that what you think is good today, there may be something very radically better tomorrow. We have to have a

philosophy and approach that does permit us to look forward to improvements.

Mr. DADDARIO. I subscribe to that or otherwise we would never get anything done.

We will proceed and give the members an opportunity to ask some questions.

Mr. Roush?

Mr. ROUSH. Mr. Chairman, I have been very restless this morning and not satisfied that we are getting exactly what this committee wants. There have been numerous committees of the Congress dealing with this problem.

Now, I agree we have to think in terms of goals. I agree that we have to identify the problems. I agree that we have to stimulate the administrators into action. Yet I feel that this committee should play a particular role in the solution of this problem. I think my colleague, Mr. Conable, hit it right on the nose when he said we need to seek the guidance of the scientists and the man who is dealing with the technological problem. This is what I hope your people will be able to give us.

Now, I think that we want to know what your researchers and scientists are doing to solve these problems.

I think that we want to know what Chicago needs by way of scientific and technological information to solve the tremendous problem they have.

What does the Potomac area need to solve its pollution problem? I think what we want to know is what are we doing scientifically? What are we doing from a technological standpoint? What in-house research are you conducting? Specifically which pollutant problems are you dealing with and specifically which pollutant problems are other people dealing with?

What contracts do we have with colleges and universities who are dealing with this problem?

What are the scientific problems?

What are the technological problems?

What can the Congress do in these areas to help solve these problems? And, what are we doing to bring together, to correlate, and to make useful the various scientific endeavors which are being conducted all through this country to make them useful and to supply the scientist with information from another area of endeavor?

It seems to me that this has to be the thrust of these hearings if we are going to be successful and meet the requirement which the chairman set out yesterday in his statement when he said:

> These hearings are designed to make clear to the Congress the technological problems of pollution abatement and research needs.

There are several questions here, Mr. Cohen, whose answers, I am sure, will be supplied as your people testify, but I did feel, Mr. Chairman, that these are questions which need answering.

They will be the real thrust of our endeavor.

Mr. COHEN. Could I say this: As you indicated, our experts are here under Mr. MacKenzie and will be glad to go into the questions you raised. If the committee would like, I would be glad to submit to the committee or put in the record so that the staff could review

them, the list of research grants that we are making, the training grants, and the contracts that we have in this field which would in some respect help you to analyze where the projects are and what we are doing in this area. I think they offer a basis for at least indicating where the areas of concern now are and whether there are any gaps in those areas.

Mr. DADDARIO. Recognizing the limitation that we have on time, the committee's practice has been to draw up a series of questions to fill in the gaps in the testimony. Our staff will be working with yours in order to do that.

Mr. ROUSH. That's all, Mr. Chairman.

Mr. DADDARIO. Mr. Conable?

Mr. CONABLE. I wondered if you couldn't emphasize the need for a coordinated approach to the problem of pollution? There must be tradeoffs between water pollution and air pollution. For instance, we could eliminate a large part of the water pollution problem if we didn't use water to carry away human waste. Yet if we incinerated such waste, we might increase greatly the air pollution problem.

This indicates, does it not, that we better not go overboard on water pollution or any other aspect of pollution without carefully coordinating our approaches?

Don't we have to approach the problem through a broad scientific program?

Mr. COHEN. I'm not qualified to speak to that scientifically, although the thought I have given to it seems to confirm what you said; namely, that there are a lot of interrelations, and I speak mainly on the health aspect where I know something about it, between all types of pollutants and pollution. Also I think that there is the aspect of the spin-off that occurs from various types of research, the longrun effects of which you can't immediately determine. So that I would tend from what I thought myself to agree with what you say.

Mr. CONABLE. But, on the other hand, it doesn't necessarily require a broad geographical approach. We obviously are going to have areas of particular concern as we move toward the megalopolis concept across the country. We are going to have large areas of the country where water pollution is not going to be a very serious problem. Actually, in some regions it is a diminishing problem. Really, what we need more than anything else are standards.

Mr. COHEN. I would like to ask Mr. MacKenzie to comment on that. You would be qualified to express an opinion on it.

Mr. MACKENZIE. I think, Mr. Conable, that you have a point here which is important to keep in mind always. There are interrelationships between the procedures that are used for controlling water pollution, air pollution, or pollution of the land as exemplified by the disposal of solid waste.

In the field of air pollution as an example, one of the prime sources of concern with respect to polluting the air comes from the incineration of solid waste. Obviously we must have satisfactory ways of disposing of the solid waste which is generated in enormous quantities in our urban communities.

At the same time we have to be very careful that in following the procedures that are necessary that we do not unnecessarily pollute the atmosphere or the water.

So, there is a close tie here and the programs must be coordinated.

The coordination relates not only to the activities, however, that are carried on on a Federal level, but importantly the activities that are carried on by the States and by the local governments.

On the local government level, for instance, one of the troublesome things in administering these programs is to effect the appropriate coordination between the department of sanitation, if it is so labeled, that is charged with the responsibility of collecting and disposing of solid waste, and the air pollution control activity that may be conducted by the same or a parallel organization in a local government.

We must incorporate in our administrative procedures the necessary coordination so that one does not unnecessarily interfere with the other.

Mr. DADDARIO. Will the gentleman yield at this point?

Mr. CONABLE. Yes, Mr. Chairman. I'm sorry, I do have to leave.

Mr. DADDARIO. You may feed this into your question. How is the coordination of water, air, and soild waste problems handled now that the Federal Water Pollution Control Administration has been transferred to the Department of the Interior from your Department?

Mr. COHEN. Could I just say in answer, because perhaps you have to go, Mr. Conable, having been a member of the State board of health some years ago, I became quite concerned about the problem that you are indicating, that there had to be more effective coordination particularly at the State level where the geographical problems of air and water sometimes differ. I mean, one community has a really serious water problem but not much of an air problem and another one has a very serious air problem and not much water, and some have both.

And, with shortage of resources and funding at the State level, I think there is a need at the State level for much more effective coordination. I'm not talking about the R. & D. aspects. I'm really talking about quality standards, enforcement, compliance, that sort of aspect.

I think I would like to ask Mr. MacKenzie again to answer that question about the interrelationship between those three aspects.

Mr. MACKENZIE. We have not yet fully developed, in my opinion, the coordination that will be necessary between the Water Pollution Control Administration which has been transferred to the Department of the Interior and the Department of Health, Education, and Welfare. There are discussions now going on between the two Departments in order to effect this coordination. The responsibility for the health aspects of water pollution was not transferred to Interior. It remains in the Department of Health, Education, and Welfare, and obviously there will be a need for continuing liaison and close cooperation in order that the interest of both Departments can be incorporated in the actions that need to be taken.

With respect to coordination between the other elements of pollution control, principally air pollution and solid waste handling and disposal, there is a continuing coordination between the Division of Air Pollution and the Office of Solid Wastes, both of which are currently operated in the Public Health Service under the Department of Health, Education, and Welfare.

There is practically day-to-day routine contact on these with interchange of information on projects that are underway with respect to how these should be handled, in what degree each of the two organizational subcomponents should work together in each instance.

Now, I anticipate that it will not be difficult to effect the coordination on water pollution that I have referred to, but because of the recent action and transferring the main activity on water pollution to the Department of the Interior, the administrative arrangements have not yet been fully consummated.

Mr. DADDARIO. Mr. Vivian?

Mr. VIVIAN. Mr. Secretary, I would like to get some further information; namely, what is the distribution of funding support among private industry, the State governments, and the Federal Government for research and development on pollution control? In my own district, for example, there are a number of firms engaged in providing and selling pollution control devices and they are fairly successful, but I have no idea how well they serve the need. What is the amount of funds provided by the States for both research and training by the Federal Government?

Mr. STERN. To the best of our understanding, the research and development in this area is funded some 60 to 70 percent with Federal funds at the present time.

We don't have very good data on the research and development projects that are being carried on in industry. We do, however, have a study jointly with the American Society of Mechanical Engineers which is by questionnaire attempting to determine the extent of the private industry involvement in research and development in this area. We expect to have data available sometime later this fall and will make it available to the committee at that time.

Mr. VIVIAN. How about training in universities? My own university has a fairly active group in this field and has for years. What is the relative split in training in universities?

Mr. MACKENZIE. May I answer this, Mr. Vivian?

Totally I think training is being supported almost entirely by the Federal Government in the air pollution field at any rate, and I can only answer for this aspect of the total problem. We are currently budgeting in fiscal year 1967 approximately $3 million for support of training in the air pollution field.

Two million of this is available for grants to universities for the support of faculty, equipment, and for instruction and similar matters.

About half a million is used for the support of fellowships for the support of individuals who attend universities other than those primarily which are receiving grants. And, about a half million dollars is used directly by the Division of Air Pollution in the Public Health Service for the conduct and support of short-term training courses to which employees of State and local governments and of industry can send their people for short-term technical course training of an intensive nature.

Mr. VIVIAN. In other words, at the present time the Federal Government sponsors this activity. Is there any possibility that it will be carried on by the States?

Mr. MACKENZIE. Well, it has not matured up to the present time. I would hesitate to make a forecast of what might happen in the future,

but I see no evidence of the States picking up any significant part of the support for this activity.

Mr. VIVIAN. On page 12 of your statement, Mr. Secretary, you refer to Senate bill 3112, which has also been sponsored in the House by a number of us. Do you feel that will have any significant effect in bringing up the level of research within the States by cooperative ventures?

Mr. COHEN. Yes, I think it will, Congressman Vivian; however, I'm not so optimistic that I think with the passage of this bill, that's the end of all legislation in this field. This problem that I have mentioned of getting the States, the localities, and the universities to accelerate work on this problem I think is going to be one of our continuing problems during the next few years.

Mr. VIVIAN. I would like to ask another question.

Yesterday Congressman Vanik of Ohio made a very able statement regarding the necessity for industry standards in pollution control. He was referring particularly to water pollution at the time, but it could be equally applied to air pollution and solids pollution. For example, we have a number of firms in my own district which generates a great deal of air pollution and the surrounding communities are most reluctant to enforce any standards. Certainly they may pass the laws, but they hate to enforce compliance because they are afraid these industries will then proceed to move away.

I felt his request for industry-by-industry standards and compliance obligations were very reasonable requests. Have you any comments on this subject?

Mr. COHEN. Well, I only heard about Mr. Vanik's suggestion last night, and I thought a good deal about it. I think it has some merit and ought to be considered I think that one would necessarily have to think of industries in a broad spectrum to consider competitive problems in industry because I think one of the problems that industry has is if it gets into any of these areas, it has to consider what its cost impact is in a competitive situation. And, there it would not necessarily, in my opinion, be what that particular industry is, but also what the competitive and alternative products were that they were really competing with.

And, again, that's exactly what I had in mind when I replied to Mr. Conable's question a moment ago.

My own experience when I was on the Board of Health, and that was some 10 years ago, is this matter of compliance at the local level is exceedingly difficult. Local officials, no matter what the law is, don't want to drive an employer or an industry or a product out of their community.

They understand what his problem is and what his cost is and unless we can get some broad base in this, so that there aren't unfair completitive advantages or disadvantages, I don't think we are going to solve some of the most difficult problems. That's one of the reasons I feel you have to look at this problem from a national point of view so that you eliminate this unfair competitive element.

Mr. VIVIAN. Is there any research study being carried on within the Department regarding the subject of industry standards or related topics?

Mr. MACKENZIE. Yes, there is. A good deal of study is being devoted to this particular subject. We have under development within the Division of Air Pollution, as an example, what we have termed "codes of good practice" that would be applicable to various industries and various industrial processes.

The purpose of this is to indicate what is feasible both technically and economically in the way of control of pollutant emissions from such activities and to make this available not only to all segments of industry, because we find in many instances that there are a fair number of small industrial concerns that are not really well informed about what can be done with respect to their operations in this regard, but also to State and local air pollution control agencies for their guidance so that their actions can be not only applicable to the existing problem, but also reasonable from a technical and economic standpoint as to what actually is feasible of accomplishment.

Mr. DADDARIO. You gave us a deadline, Mr. Secretary, and in the event there are further questions, we will see to it that you get them. We are very happy to have had you here.

Mr. COHEN. Thank you.

(The biographical statement and complete prepared statement of Wilbur J. Cohen follows:)

BIOGRAPHICAL STATEMENT ON WILBUR J. COHEN

Wilbur J. Cohen was appointed Under Secretary for Health, Education, and Welfare on June 1, 1965. He was previously Assistant Secretary for Legislation, having been appointed to this post by President Kennedy in 1961. He was responsible for handling some 65 major legislative proposals which became law during the 4½ years he was Assistant Secretary for Legislation.

He is on leave as Professor of Public Welfare Administration at the University of Michigan where he taught from 1956 to 1961. He was Chairman of President Kennedy's Task Force on Health and Social Security in 1960 which recommended Medicare and other health and social security proposals.

He was the research assistant to the Executive Director of President Roosevelt's Cabinet Committee on Economic Security from 1934 to 1935 which drafted the original Social Security Act. He has been intimately connected with all of the legislative developments in the social security and public assistance programs since 1934 and has been closely associated with the recent medicare, medical school, and education legislation.

Mr. Cohen was born in Milwaukee, Wisconsin, in 1913. He is married to Eloise Bittel of Ingram, Texas, and is the father of three sons.

He graduated from the University of Wisconsin in economics in 1934 and also received the honorary degree of Doctor of Laws in 1966.

He is the author of several books and many articles in the social security, health and welfare field and is a recipient of a number of awards for distinguished service in health, education, and welfare.

PREPARED STATEMENT OF WILBUR J. COHEN, UNDER SECRETARY, U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Mr. Chairman and members of the committee, it is a pleasure to participate in these important hearings on the problems of environmental pollution and their control. In all our cities and towns, people are becoming increasingly concerned about the rising contamination of such environmental resources as air and water. They are becoming increasingly concerned about the very real and serious threat that such contamination poses to human health and welfare. I congratulate the Subcommittee on undertaking such a timely review of such a significant matter.

You may be sure, Mr. Chairman, that we in the Department of Health, Education, and Welfare share your concern with the adequacy of technology for abate-

ment of environmental pollution, both now and in the future. I think it is important to distinguish between the Nation's present and future needs in this area. On the one hand, we already have at our disposal enough technical know-how to achieve a significant degree of control of many of our most serious environmental pollution problems. Our most immediate need, then, is to see that this technology is applied, and this is a challenge which clearly calls for the development of appropriate control programs at all levels of Government.

But there can be no doubt that a need also exists for better control technology to arm us against future pollution problems. The search for more effective and more economical control techniques must be an integral part of any national attack on environmental contamination. Moreover, to protect ourselves and future generations against the projected growth of many pollution problems, we will almost certainly need to find ways of maintaining our high levels of economic and technological progress without adding to our already substantial capacity for polluting the environment.

These tasks will, of course, require a continuation, indeed expansion, of present research and development activities in the field of environmental pollution. Both Government and industry have a responsibility to share in this vital work. Those industries which are significant contributors to pollution as well as others which have technical capabilities in pollution control have both a responsibility and a great opportunity to help the Nation fight pollution. Insofar as the Federal Government is concerned, we in the Department of Health, Education, and Welfare have always felt that research and development constitute an essential part of our programs in environmental pollution. Through our own research activities and through support of research by non-Federal agencies and institutions, we are engaged in a constant effort to raise the level of the Nation's technical capability for controlling pollution in all its forms.

In order to make an informed appraisal of the present status of efforts to control environmental pollution problems in this country and to provide a sound basis for deciding on the scope and direction of future efforts, it is essential that we take a brief look at the roots from which these problems arose and the ways in which they have grown and evolved.

Environmental pollution problems are a by-product of many interrelated factors in the development of our present way of life. To deal with such problems intelligently, we must place them in their social and historical perspective. It is my intention, Mr. Chairman, to discuss this subject in broad outline and then to look more closely at the specific problems of air pollution and disposal of solid waste.

In this century, our remarkable progress in science and technology has given us an unprecedented capacity to alter man's environment—both by choice and by chance. We can and we are reshaping it by deliberate choice through the application of our increasing scientific and technical knowledge. And for the most part, the results have been of immense benefit to all of mankind.

But there is another side to the coin of technological miracles—the side that has been tarnished by some of the unplanned and unforeseen consequences of the ways in which the very same scientific and technical knowledge has been used. The problem of air pollution and the many problems associated with disposal of solid wastes are among the most important consequences of our failure to anticipate and prevent environmental contamination arising from the heedless application of technical knowledge.

This country has arrived very belatedly at its present point of sharpened interest and activity in the field of environmental pollution control. We have just begun to recognize that man's ability to contaminate his environment has long since surpassed the essentially limited capacity of our air and water to purge themselves of such contamination. And we are only beginning to see in all its complex ramifications the vital connection that exists between man's well-being and the quality of his environment. That we have been tardy in this respect is not really surprising, for environmental contamination, in contrast to the immediate short-term benefits of technological innovation, is essentially a slow and subtle process, and some of the most important health and welfare hazards of such contamination are not always readily apparent. Our understanding of these problems is still incomplete, but where our knowledge is not complete, the areas of uncertainty relate not to whether environmental contamination threatens public health and welfare—for that is not in doubt—but to the question of how best to deal with a serious problem before it reaches truly critical proportions.

The adverse effects of air pollution are already very serious. Air pollution threatens the American people in many diverse ways. Its impact is felt directly or indirectly in virtually every part of the United States, in both large cities and small towns and in agricultural and recreational as well as industrial areas.

There are many important reasons why better control of air pollution is urgently needed now. Air pollution, by interfering with visibility, sometimes imperils air and highway transportation. Polluted air soils, corrodes, and otherwise damages property and goods, including buildings and monuments as well as clothing and home furnishings. In our large cities, buildings must be scrubbed to prevent them from deteriorating; the bill for cleaning a 50-story building can run into the hundreds of thousands of dollars. Some of the damage caused by air pollution cannot be repaired at any price. In many cities abroad, historic buildings and sculpture that withstood the ravages of time and weather for hundreds, sometimes thousands, of years are now crumbling under the onslaught of pollution. The magnificent Parthenon in Athens is just one of many irreplaceable structures that are under attack from corrosive air pollutants. No amount of money spent to clean up the filth left behind by air pollution will keep this sort of thing from happening. Only an adequate investment in control action can accomplish this.

The damage done by air pollution is not limited to urban places, Mr. Chairman. Air pollution affects forests and farmlands and farmers as well. It causes hundreds of millions of dollars of damage to crops each year. It contributes to urban decay and deterioration of property values. In total, the economic losses resulting from uncontrolled air pollution are estimated to be 11 billion dollars annually. And this figure, Mr. Chairman, represents only the price of living with polluted air and, to some extent, cleaning up the dirt it leaves everywhere. Currently, then, the costs of inadequately controlled air pollution are measured in the billions of dollars annually, while the costs of control action are in the millions. Clearly, the cost to society as a whole for cleaner air would be considerably less than what we are now paying. We need to keep this fact in mind when we try to assess the true cost of controlling air pollution.

Even if the problem of air pollution threatened only our pocketbooks, we would have ample reason to increase and accelerate our efforts to deal with it. But the fact is that we have an even more compelling reason, for air pollution poses a very serious threat to the public health—to your health and mine.

There is no doubt that air pollution contributes to the occurrence and worsening of such chronic respiratory diseases as lung cancer, emphysema, chronic bronchitis, and asthma. There is even some evidence that certain types of air pollution may contribute to the occurrence of those upper respiratory diseases known generally as the common cold. We know from tragic experience that ordinary air pollutants in higher than ordinary concentrations have caused mass illness and death, both in European cities, notably London, where thousands of people died in a 1952 air pollution disaster, and to a lesser extent, in the United States, in such a relatively small community as Donora, Pennsylvania, as well as in such large cities as New York, where at least two episodes are known to have occurred. The harmful effects of air pollution at the levels that are commonplace in many American cities and towns are less obvious, but the accumulated evidence from epidemiological and statistical studies as well as laboratory and clinical investigations leaves no room for doubt as to the connection between long-term exposure to polluted air and the occurrence of illness and death from chronic respiratory disease. The threat to health is, in my view, the primary reason why, in the past decade, the American people and their representatives in the Congress have called increasingly for decisive action at all levels of Government to put an end to contamination of the air we breathe.

Mr. Chairman, we have brought together a great deal of the existing scientific information on this problem in order to make available documentation of the health hazards of air pollution. I am submitting this report for the record. It is entitled "The Health Hazards of Community Air Pollution."

All of the major trends that contribute to air pollution are rising. Our production and consumption of goods and services are increasing. The number of motor vehicles on our streets and highways is increasing. Our demands for heat and electric power produced by the burning of fossil fuels are mounting. In addition, the onward rush of technology is continuing and is constantly adding new and more complex dimensions to the air pollution problem.

The impact of all these trends is magnified and reinforced by the continuing trend toward greater concentration of people and sources of air pollution in our

urban areas. Today, more than one-half of the Nation's total population of some 190 million people lives on about 10 percent of our land area. Estimates are that by 1975, the population will reach 235 million with three-fourths of it concentrated in the same small land area.

In the face of these anticipated future rises in the trends that contribute to air pollution, we must recognize *that the amount of air available for our use will remain constant. There is no way to increase it.* Our only sensible recourse is to control the sources of pollution.

We now know that we can no longer be content with control efforts which are focused almost entirely on abatement of the most obvious and bothersome types of pollution. A more comprehensive and more sophisticated effort is needed to deal with the air pollution problem in its present dimensions and to prepare for its expected future growth.

While the control of the many sources of the problem is clearly the only practical solution to air pollution, this does not necessarily mean that the application of control devices or process changes represent the only means of source control. Such matters as the proper selection of fuels, proper location of installations or facilities that can contribute to air pollution, a decision to invest in mass transit facilities rather than in a new highway can also be means of source control. These and similar considerations must be taken into account if we are to mount a really effective attack on air pollution in the second half of the Twentieth Century.

Our Department's experience in this field makes it clear that major reliance must be placed on measures designed to control the sources of pollution and that effective regulatory control programs at all levels of Government are the only really practical means of achieving our goal. Those who seek an oversimplified, single, painless solution to air pollution are, in our opinion, refusing to face the technical, economic, and social facts that bear on the problem.

The challenge that confronts us, then, is twofold: first and most immediate, to find the means of insuring that existing control technology is applied to the fullest possible extent, and second, to find solutions to those technical problems which still stand in the way of bringing air pollution under fully effective control. There can be no doubt, Mr. Chairman, that there is now a very substantial body of technology for the control of air pollution. To be sure, technical knowledge and skills in this area are continuing to expand and improve, *but the fact remains that full application of what is already available would produce a significant reduction in community air pollution problems.* This is not to say that research and development to find new and better control techniques should not be pursued as vigorously as possible; both Government and industry have important responsibilities in this area. But at the same time, we must redouble our efforts to insure application now of the techniques and equipment available for reducing pollutant emissions from many of the most important sources of air pollution in our cities and towns. As a matter of fact these approaches are so interdependent that it can be misleading to view them separately. The application of existing technology stimulates the improvement of technology as no other single factor can. In return, the resulting improvement of technology enhances and facilitates improvements in the economic application of controls.

The task of insuring wide application and improvement of technology for the control of air pollution is one which clearly calls for action by all levels of Government and by industry. The need for such action was recognized by the Congress when it adopted the Clean Air Act in December 1963 and again when it enacted major Amendments to the Clean Air Act in October 1965, including the Motor Vehicle Air Pollution Control Act and the Solid Waste Disposal Act. A major purpose of the activities which the Department of Health, Education, and Welfare is carrying on under this legislation is to provide national leadership and assistance to State and local governments in seeking abatement of air pollution.

The Federal air pollution program now includes research and training activities, financial and technical assistance to State and local control agencies, action to abate interstate air pollution problems, and the establishment and enforcement of national standards for the control of air pollution from new motor vehicles. Mr. Stern will describe many of these activities in greater detail, Mr. Chairman; I want to discuss briefly some aspects of this program that are particularly germane to these hearings.

In the Clean Air Act, the Congress authorized a new Federal activity which was clearly intended to stimulate State and local control efforts. I am referring to a matching-grant program under which we have thus far awarded some $9 million to State and local agencies to assist them in developing or establishing new control programs or improving existing programs. Because agencies receiving these grants are required to increase their own spending for control activities, the awards we have made to date have resulted in an estimated increase of about 65 percent in the total amount of funds available for air pollution control programs in our cities and States. An increase of such magnitude is unprecedented in this field.

In many of its other provisions, too, the Clean Air Act reflects the philosophy that regulatory control action is the most effective way of taking full advantage of the technical capability that exists for dealing with air pollution problems. A prime example is the authority that was provided for direct Federal action to abate interstate air pollution problems. These problems arise in large measure, Mr. Chairman, from air pollution sources that can be controlled but are not being controlled, primarily because the people whose health and welfare they endanger live in a State other than that in which the sources are located.

In the Clean Air Act Amendments adopted less than a year ago, the Congress again called for regulatory action to deal with an important air pollution source that is national in its impact—the motor vehicle. Under this legislation, Federal standards have been established by Secretary Gardner to which gasoline-powered vehicles will be required to comply, beginning with the 1968 model year. This is a very important step. Motor vehicle pollution affects more people across the country than does any other single segment of the total air pollution problem. It is national in scope and of growing magnitude. Its impact on health and welfare has been extensively studied and is documented in reports to the Congress from our Department; I have copies of the reports with me, Mr. Chairman. To cite just one of the ways in which motor vehicle pollution is changing the environment, we know that it causes widespread damage to vegetation. In the State of New Jersey, in a recent year, 38 vegetable, ornamental, grain, and fruit crops suffered damage; every county in the State was affected. In California, photochemical smog has made it impossible to raise crops in many areas where such activity was once profitable. Nationally, as long ago as 1962, evidence of damage to plants and material from motor vehicle pollution had been observed in parts of 27 States.

The evolution of efforts to control motor vehicle pollution illustrates the importance of regulatory control action in the air pollution field. A little more than a decade ago, when motor vehicle pollution was first identified as a major factor in the occurrence of photochemical smog, appropriate control techniques were not available. The development of technology that has since made it possible to begin controlling this problem nationally was clearly stimulated and accelerated by the regulatory control legislation developed and passed by the State of California in 1959.

To help take care of some of the major unsolved problems in air pollution control, the Clean Air Act authorized an accelerated research and development effort at the Federal level. In both the Clean Air Act and the recent Amendments, the Congress directed that particular emphasis be given to the development of control technology for motor vehicle pollution and for sulfur oxide pollution arising from the combustion of fossil fuels. Our research efforts include both the activities of our own scientific staff and work being supported by grants to non-Federal institutions and organizations and contracts with private industry. Additional research is being sponsored through project agreements with other agencies of the Federal Government. Mr. Stern will describe all of this in much greater detail. I simply want to note at this point that we regard our research activities as an integral part of the total Federal effort to bring air pollution under better control.

GOALS FOR ACTION

Mr. Chairman, in the Clean Air Act, the Congress paved the way for a major new attack on air pollution. The response of State and local governments has been encouraging, as I have already noted. The influence of the Clean Air Act is reflected importantly also in changing attitudes toward air pollution control on the part of science, industry, and the American public. But we must not be complacent about the present status of efforts to deal with this deceptively subtle problem. The development of a truly comprehensive national effort to

control air pollution is still very much a goal rather than an accomplished fact. As President Johnson has pointed out, we have only begun our work. The great majority of Americans are still not served by really effective State and local control programs. For the most part, the State and local agencies charged with responsibility for preventing and controlling air pollution do not yet have adequate budgets, manpower, or legal authority.

To indicate the extent to which all levels of Government and industry must augment their efforts we have established goals in three important categories and a timetable for reaching them. In each instance, it is apparent that reaching these objectives will require wide ranging efforts by Government as well as industry. And often, it will be necessary to adopt interim measures to keep specific problems from getting out of hand while we work toward the development and application of more permanent solutions.

The first such goal is a 25 percent reduction in air pollution from industrial and municipal sources by 1975; this applies primarily to manufacturing and processing activities and to such municipal activities as burning and incineration of refuse.

To accomplish this goal, there must be a substantial expansion of State and local control efforts and of research and development activities both by Government and industry. The Federal Government will clearly have to provide leadership and assistance in both of these areas.

With respect to the Federal responsibility to support State and local control efforts, Senate Bill 3112, which has just recently been passed by the Senate, would enable us to take further steps toward meeting this vital responsibility. The Bill would authorize grants to State and local governments to assist them in maintaining effective control programs; this would be in addition to our present authority to award grants to stimulate the creation of new programs or the improvement of existing programs. The proposed new activity will enable the Department of Health, Education, and Welfare to help State and local governments meet the need for sustained, long-range efforts to deal with their air pollution problems. In addition, Senate Bill 3112 proposes needed increases in authorized appropriations for our air pollution activities for the current and the next two Fiscal Years.

To achieve a 25 percent reduction in air pollution from industrial sources, we must also seek ways of stimulating private investment in research and control efforts. Currently, non-Governmental effort in this area is not at all commensurate with the magnitude and seriousness of the problem. In large measure, this reflects inadequate regulatory control action in our cities and States. But it is also due in part to the lack of economic incentives. Since research and control activity generally does not increase the efficiency of industrial operations or improve the quality of goods and services, such activity is often given a very low priority. The usual economic incentives of the free market have not been in the past, and are not now, an effective stimulus to industry efforts in the air pollution control field. A sound regulatory program with uniform legal requirements to insure equality of treatment among competing industries is an effective stimulus which encourages industry efforts to improve and apply control technology.

Our second goal concerns sulfur oxide pollution from the burning of fossil fuels, primarily at such large installations as electric power plants. This is one of the most important air pollution problems for which control technology is still deficient; however, several promising approaches have been developed and are ready for full-scale testing. Our goal is to demonstrate the feasibility of such techniques by 1970.

But because sulfur oxide pollution is already a serious problem in many large urban areas, it is essential that interim measures be adopted to keep the problem from worsening. In brief, such measures involve greater consideration of air pollution problems in decisions on the allocation and use of fuels. We are already trying to encourage greater use of low-sulfur fuels in areas where the sulfur oxide pollution is now serious. In addition, serious consideration must be given to modifying our national fuel-import policies in order to give priority to low-sulfur fuels and to locating major new fuel-burning installations, primarily power plants, outside urban areas.

The third goal oncerns motor vehicle pollution, which I have already discussed briefly. Our objectives here are a 25 percent reduction in this problem by 1975 and a forty percent reduction by 1985. In our view, these goals can be achieved by improvements in control technology applicable to the internal combustion engines. But even the most effective technology we can envision will

not be adequate to keep this problem from worsening in the face of projected future increases in our use of motor vehicles. More than 85 million motor vehicles are now in use in the U.S. and this number increases every year. It is estimated there will be 120 million vehicles in use by 1980.

For the future, then, the development of alternate power sources with less inherent potential for polluting the air is essential. The necessary research cannot be started too soon. To insure that such systems will be available in time to keep the motor vehicle problem from reaching critical proportions, prototype models must be available for testing by 1985. This major challenge will obviously require the combined research efforts of Government and industry. Our pending budget request, Mr. Chairman, includes funds with which we can begin planning our own efforts in this area and encouraging industry as well as private research institutions to undertake similar work.

The disposal of solid waste materials is a major factor in many of our most serious environmental contamination problems. The burning and incineration of refuse contributes to air pollution in all parts of the country. The growing piles of waste materials lying in and around countless American communities contribute to water and soil pollution. And heedless disposal of refuse is, of course, an important cause of the ugliness that blights many of our fairest cities and towns and is increasingly spreading into the countryside.

In years to come, this problem can only worsen unless we make a conscious effort to bring it under control. As the economy moves upward, we not only produce and use more goods, we also discard more. As technical advances are translated into new products and materials, the character of what we throw away becomes more varied and more complex. Moreover, since control of air and water pollution often yields solid waste material, our progress in these areas may also add to the growing waste disposal burden.

To dispose of the mounting volume of solid waste without polluting air, water, and soil, and thus threatening public health, is an incredibly complex challenge. As yet, we are not now equipped as a Nation to meet it. But now, for the first time, there is hope that we are on the road to finding the necessary capability. Under the Solid Waste Disposal Act of 1965, the Department of Health, Education, and Welfare is mounting a national program to deal with the waste disposal problem. The program includes research, technical assistance, and training activities, as well as projects to demonstrate new and promising ways of managing solid waste problems and grants to States to assist them in surveys of refuse problems and planning of needed programs. I am pleased to note, Mr. Chairman, that this program is getting underway very rapidly. Mr. Gilbertson will report on this in greater detail.

I just want to point out that here, too, that Secretary Gardner and I are committed not to any single approach, but to full exploration of *all* promising ways of dealing with the problem. Among the most important needs in this field are a better understanding of the extent and control of such problems as the breeding of disease-causing organisms and contamination of ground waters by landfill operations and substantial technical improvements in both the operation of landfills and the design and operation of incinerators. The possibilities of recapturing and using heat from incinerators and of converting refuse to soil conditioners are also deserving of close attention.

In the long run, Mr. Chairman, it will not be sufficient merely to find better ways of disposing of refuse, though this is surely an important objective. Wherever possible, we must also seek and apply ways of reducing the volume of materials discarded from homes, offices, and factories, as well as ways of recovering materials which may be re-usable. The end result, if we are successful, will be a very important step toward a more beautiful and more healthful environment for all Americans.

Mr. Chairman, I have tried this morning to throw some light on the many complex ramifications of environmental contamination and to suggest the broad approach which we in the Department of Health, Education, and Welfare feel is the most promising way of bringing these problems under effective control. In the course of these hearings, you will undoubtedly hear testimony from many persons whose views differ from ours with respect to the seriousness of many environmental contamination problems and the relative merits of various ways of dealing with them. Such differences of opinion are to be expected when the subject is as complex as this one. I think it is important, however, that we assess these varying points of view in the full light of some basic facts about environmental contamination and our present understanding of its impact on society.

In the relatively short time since we in the United States began awakening to the threat of environmental contamination, we have been able to reach only a broad and tentative understanding of its nature and effects on man. Our present knowledge suggests that the many contaminants to which we are all exposed threaten our health and welfare in many devious and subtle ways. To judge the full magnitude and seriousness of the problem requires a great deal more than just a superficial look at its most obvious consequences.

In many respects, our progress in understanding the problems of environmental contamination has been uneven. We have long since learned, for example, that regulations are needed to guard against the ingestion of small amounts of toxic substances in food and to insure the purity of drugs. In the area of occupational health, there is broad understanding of the need to protect workers against many of the most obvious hazards inherent in their daily job activities. But we have only begun to develop an awareness of the full implications of contamination of the environment. That we have lagged in this respect is indeed tragic, for it is contamination of the natural environment that has the greatest potential for affecting the total population, including infants and children as well as the elderly, the healthy as well as the ailing, and adults of all ages, regardless of their occupations.

The Department of Health, Education, and Welfare has a long experience in dealing with all of the ways in which contaminants may reach man. Our experts pioneered in developing research and regulatory programs to protect the public health and welfare from food, drug and water contaminants and from a host of communicable diseases which once caused death and disability in truly tragic proportions. By identifying the interrelationships that exist among all of the various ways in which man is exposed to the toxic by-products of our technologically advanced society, the Department assesses the overall dimensions of the threat posed by environmental pollution. Mr. Chairman, this is very important, because an adequate air pollution control program must take into consideration the other vectors of disease and disability which compound its effects.

I said a few moments ago that we have just begun to recognize that man's ability to contaminate his environment has long since surpassed the essentially limited capacity of our environment to purge itself of such contamination. I submit that the Clean Air Act of 1963 and its Amendments of 1965, and the beginning we have made toward implementation of this Congressional mandate are firm evidence that this recognition is real and concrete. The several approaches toward control of the problem in which we are now engaged—research and training activities, financial and technical assistance to State and local control agencies, and direct Federal abatement action on problems beyond the reach of other levels of government—offer a sound foundation on which future improvements can be built. That we must, all of us, seek improvements is a point on which there can be no serious disagreement. The forces of growth and change which leave in their wake problems of environmental contamination continue to accelerate with each year that passes. The Department of Health, Education, and Welfare is pledged to carry out the Congressional mandate for a clean and healthy environment for all Americans.

Mr. DADDARIO. Mr. MacKenzie, please come forward.

Mr. MACKENZIE. Thank you.

Mr. DADDARIO. As I understand, Mr. Stern will give the next statement.

Mr. STERN. Yes.

Mr. DADDARIO. Proceed, please.

STATEMENT OF MR. ARTHUR C. STERN, ASSISTANT CHIEF, DIVISION OF AIR POLLUTION, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Mr. STERN. Mr. Chairman and members of the committee, I have submitted for the record a rather lengthy statement of 78 pages and certainly I wouldn't burden you with that amount of reading. I have an abbreviated statement of 12 pages. If in your time schedule this

is too long, I can even abbreviate that further, but I would prefer to read it into the record.

Mr. DADDARIO. I think a 12-page précis is all right.

Mr. STERN. Thank you.

I am pleased to have this opportunity to appear before you and to review the adequacy of present technology for controlling the problem of air pollution in this country.

Air pollution, as recently as the early 1940's, was perceived as a relatively simple problem having to do with the emission of black smoke and cinders, and confined to a relatively few eastern and midwestern industrial cities. The technology for controlling this kind of air pollution consisted of improvements in combustion practices, restrictions on the kinds of fuel used, and in some cases, devices to control cinder emissions. When smoke became so intense in some cities as to bring on a public clamor for relief, this technology was applied and, with considerable help from the fortuitous change from steam to diesel powered locomotives and the substitution of gas and oil for coal in space heating, the atmospheres of these cities visibly improved.

Today, Mr. Chairman, as you are well aware, the air pollution problem is known to be much more complex than this, and its effects are infinitely more serious than was once suspected. Moreover, these effects are felt daily in every region of the country.

As Under Secretary Cohen has pointed out, there are many cogent reasons why we must control air pollution. But by far the most compelling reason, the principal reason why the American public and its representatives have demanded that we restore the atmosphere, is that air pollution contributes to illness and death.

Just as our perception of the nature of the air pollution problem has changed drastically in the past few decades, so has the problem changed, and so has our ability to deal with it changed. In 1955 when the Federal air pollution program was initiated, there was little exact knowledge of the kinds and quantities of pollutants in the air, or of the mechanisms by which they accumulate or are dispersed. The national air sampling network and the continuous air monitoring program, both operated by this Department have since gathered extensive data on the amounts and chemical composition of particulates in the air, and the concentrations of such gaseous pollutants as nitrogen dioxide, nitric oxide, carbon monoxide, oxidants, total hydrocarbons, and sulfur dioxide. Advances in meteorology have enabled us to gage the atmosphere's total mixing or absorptive capacity over a particular geographic region, and thus to estimate the degree of air pollution control needed for a given area.

The technological means of controlling the sources of air pollution have also been rapidly developed in the past several years. Particulate pollutants can be removed by devices which employ principles of filtration, electrostatic precipitation, or centrifugal force. Gaseous pollutants can be taken out through liquid scrubbing, vapor recovery, combustion, and solid adsorption. Open burning, once widely employed to dispose of a city's trash and to get rid of leaves, upholstery in scrapped automobiles, battery cases, tires, and so forth, can and has been in some cases replaced by processes which do not pollute the

atmosphere. Smoke pollution from domestic, commercial, and industrial incinerators, boilers, and heating systems can be largely eliminated through improved fuel burning equipment and proper firing practices. Carbon monoxide and unburned hydrocarbons discharged from the gasoline-powered motor vehicles have been brought under partial control. In fact, through control devices or through process modification most sources of air pollution in the United States today can be brought under control.

None of this is to say that we can afford to be complacent about the presently available technology for controlling air pollution. There are some pollutants, like the nitrogen oxides, which today rarely, if ever, reach what are thought to be harmful levels in many regions of the country. We do not have adequate technology for controlling nitrogen oxides. There are some pollutants, like the sulfur oxides, which today almost constantly reach harmful levels in most of our metropolitan areas, and the increasing use of sulfur-bearing fuels for energy and other purposes will undoubtedly aggravate this problem in the years ahead. We have reached the prototype stage in one approach to controlling the sulfur oxides, but for the most part we can control sulfur pollution today only by using low-sulfur fuels. There are some sources of pollution, like the automobile, whose emissions we can today partially control, and the federally required national application of this control to new cars in the fall of next year will be a significant step in halting pollution from the motor vehicle. But the rapidly increasing number of automobiles will in the next two decades wipe out the gain from today's partial controls. Further, Mr. Chairman, we cannot be complacent about the attractiveness of much of the technology for controlling air pollution. Pollution controls generally do not increase the efficiency of industrial production or improve the quality of the product. In fact, since in our marketplace the focus is on minimizing costs and maximizing returns, present-day pollution controls, which add to costs and not to returns, are frequently considered an impediment by those who operate the sources of pollution. We can expect that this attitude will prevail as long as regulation of pollution varies from place to place, or until the technology of pollution control is developed to the point where control is not considered to be an economic impediment to industry.

In the testimony I have submitted for the record, I have included detailed discussion of the technology for control of the major sources of pollution with which we are concerned nationally. These are: motor vehicles; stationary combustion sources, with particular emphasis on the technology of sulfur removal from flue gas and fuels; petroleum refineries; steel mills; the chemical industry, both organic and inorganic and including the fertilizer manufacturing industry; foundries; and pulpmills. I will, therefore, skip over this portion of my testimony so as to use my remaining time to discuss with you the systems approach to air pollution control and, in broad terms to outline the extent of the Federal air pollution research and development program. This program is described in my written testimony in greater detail.

The air resource management or systems approach to air pollution control is most effective when coupled with 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 them if we are to define capacities for physiologic and toxicologic actions.

As you know, Mr. Chairman, in the Clean Air Act the Congress recognized the need for yardsticks of air quality, calling upon the Secretary to publish criteria reflecting the latest scientific knowledge of the predictable effects of various pollutants in the atmosphere. This Department has prepared in preliminary form criteria for two principal classes of pollutants, the sulfur oxides and the photochemical oxidants, and is working on criteria for two other classes, the nitrogen oxides and carbon monoxide. It is hoped that these criteria will assist the States and local governments in establishing air quality standards.

The second problem we must solve if we are to apply the rational approach to air pollution control is technical. We do not have today

fully developed methods of bridging the gap between air quality standards and source emission standards.

Our methods are particularly deficient for that very situation in which air pollution is most critical—the multiple source or urban situation. For suspended particulate matter we can approximate the transition using emission inventory techniques. The particulate matter emitted from each source in an area can be estimated, and from a comparison between the overall estimate and the air quality standard a percentage reduction can be calculated. For some gases and fine particles computer programs have been written to accommodate a large number of sources of different categories, to take into account varying times of maximum emissions, and to take into account varying meteorological conditions. However, these programs require a wealth of data, and they have not been developed to the point where they will accommodate reactions between pollutants after they leave the source, such as the reactions which result in photochemical smog, and they will not accommodate particulate matter that falls out, or nuisances, such as odors, which usually emanate from a single source.

Mr. Chairman, this concludes my review of some of the problems associated with our present technology for controlling air pollution. I would like finally to briefly describe for you some of the forms and the extent of Federal Government efforts to advance that technology.

The functions of conducting and supporting research have been an integral part of our Department's air pollution activities ever since the establishment of the Federal air pollution program in 1955. In fiscal year 1966, which ended on June 30, about $14 million was invested in research activities. This sum represented some 55 percent of the funds appropriated for the air pollution program. For the current fiscal year, our budget requests includes about $18 million for research activities.

Of the total for fiscal 1966, about 30 percent was allocated for research in our own facilities, mostly at the Robert A. Taft Sanitary Engineering Center in Cincinnati. About 10 percent was used to support research by other Federal agencies—the Environmental Sciences Services Administration and the National Bureau of Standards of the Department of Commerce, the Bureau of Mines of the Department of the Interior, and the Tennessee Valley Authority. Contracts with non-Federal institutions and agencies, including industrial firms, account for 20 percent. The largest single portion, about 40 percent, was awarded to nonprofit institutions, mostly universities, to support needed research projects.

This research effort includes a broad range of investigations of the nature, extent, sources, effects, and control of air pollution, and the scientific disciplines involved include many branches of the physical and biological sciences. Among the more important elements of the program are laboratory studies of the adverse effects of air pollutants on animals and clinical studies of effects on man, epidemiological and statistical studies of the occurrence of illness and death in relation to various measurements of air pollution, field investigations of the effects of pollutants on materials and structures, engineering investigations of the nature and control of pollution from such major sources as motor vehicles, fuel combustion, and manufacturing activities, and studies in the social sciences.

Other Federal agencies play an important role in our research efforts. The Weather Bureau of the Environmental Sciences Services Administration of the Department of Commerce has carried the major burden of meteorological studies. The Bureau of Mines of the Department of the Interior is engaged in numerous projects relating to the nature and control of pollution from fuel combustion, primarily sulfur oxide pollution from the combustion of fossil fuels. The Tennessee Valley Authority is active in meteorological and engineering studies relating to pollution from large fuel-burning installations; the Agricultural Research Service and the Forest Service of the Department of Agriculture in studies of air pollution effects on plant life and the Bureau of Standards of the Department of Commerce in studies of the basic chemistry and physics of air pollution. The Library of Congress has been our principal bibliographical resource.

Although not in contrast to the above noted agencies, recipients of air pollution research funds by transfer from this Department, the Office of Coal Research of the Department of the Interior, the National Science Foundation, the National Space and Aeronautics Agency, the Atomic Energy Commission and the Department of Defense have all sponsored research of great value to a better understanding of air pollution, its effects and its control.

I have given a rough indication, Mr. Chairman, of the extent of the air pollution research and development activities that are presently being carried out in the United States. I will be pleased to submit for the record a detailed breakdown of our Department's activities in this area. Mr. Cohen has already given you some material. We will provide other material in addition. Further, as I previously responded to Mr. Vivian's question to Mr. Cohen, under an arrangement with the American Society of Mechanical Engineers we are currently gathering detailed information on the air pollution research and development activities being carried out under other than Federal auspices. This information should be complete sometime in the fall of this year, and I will be pleased to make it available to the committee.

To conclude my remarks, Mr. Chairman, we have studied the report of the Research Management Advisory Panel to your committee, and we are in agreement, in large part, with the fundamental findings of the report. As the report indicates, the quality of life is to a large extent dependent upon the quality of the environment. But it is only in recent years that we have begun to understand this relationship, and particularly to understand how dependent we are on our fundamental resources of air, water, and land. For the greater part of our historical development our interest in the environment was primarily that of subduing nature so that she would serve man better. We had to convert many of our beautiful rivers and lakes into practically open sewers before we concluded that we must conserve our water resources, and we had to experience the tragedy of Donora and the anguish of Los Angeles before we began to realize that the seemingly infinite ocean of air that surrounds this planet has decidedly finite capacities for diluting and dispersing the wastes we throw up from our civilization. In our single-minded devotion to achieving the benefits of science and technology, we plunged ahead with the abundant materials at hand, without a very precise notion of where we were going and

without serious attention to the possible side effects of our activities on the environment. Today, it is apparent that we can no longer with impunity discharge wastes indiscriminately to the environment. It is apparent today that we must use our science and technology to control the byproduct problems of our industrialized society, as well as to produce the goods and services we all increasingly enjoy. And it is apparent that we are going to have to run very hard in the immediate years ahead just to keep pace with the problem. We must greatly expand our application of technology to the sources of pollution, and we must accelerate our efforts to further develop that technology. I am convinced, Mr. Chairman, that the attention focused on these needs by this committee will make a substantial contribution to our progress toward the control of environmental pollution.

Thank you.

Mr. DADDARIO. Mr. Mosher?

Mr. MOSHER. Mr. Stern, just a question concerning the Department's research activities.

Page 14 of Secretary Cohen's prepared testimony has to do with motor vehicle pollution, and he says there, "but even the most effective technology we can envision will not be adequate." Is your Department funding research, either in-house or independently, which you might refer to as "far out"—that is, technology which, even though you can't envision it today, may become a reality tomorrow? Are you using some of your research funds independent of the automotive industry, looking for "breakthroughs" that will make this statement of Secretary Cohen no longer true?

Mr. STERN. In our research plans for this fiscal year, we have allocated approximately a hundred thousand dollars for studies in the so-called far-out area that you are talking about—the electric battery-type automobile, the fuel cell-type automobile. We recognize that this is such a small sum that it can do no more than accumulate the necessary information on which to base a much more substantial program that can be recommended at a later time.

Mr. MOSHER. You are hoping, though, to put some people with creative capacity to work on this?

Mr. STERN. Yes; we already have some people who are quite conversant with the field, have made a number of visits to places that are working in this technology and assembled a large amount of data, so that we are in a position at this time to get an appreciation of the nature of the work that has to be done in order to even start on investigations in this far-out technology.

Mr. MOSHER. For example, I heard the other day about claims by a Professor Melman, of Columbia, concerning ideas that he has for reverting to steampower but using combustion from fossil fuels in a way that would not pollute the atmosphere. Does this committee have assurance that you folks are considering ideas like that even though they may sound impractical? Are you working on that sort of idea?

Mr. STERN. We have no reservations on new ideas. We are prepared to encompass any and all ideas in this far-out technology because we recognize that when you are looking this far in the future, you can't draw a diagram as to just what the vehicle is going to look like. You have to accept ideas which include the use of steam, the use of bat-

teries, the use of fuel cells or, as I believe Professor Melman has also indicated, a vehicle that stores up energy in a rotating flywheel, and which occasionally stops at a place where an electric motor can resupply energy to the flywheel. All of these ideas are grist for the mill.

Mr. MOSHER. That is all.

Mr. DADDARIO. Mr. Brown?

Mr. BROWN. No questions.

Mr. DADDARIO. Mr. Ryan?

Mr. RYAN. Mr. Chairman, I was concerned about a statement on page 12 of the Secretary's statement. He stated that the first goal is a 25-percent reduction in air pollution from industrial and municipal sources by 1975. My question is, could we get a greater reduction if we spent more money? And, if not, why not?

Mr. STERN. 1975 is quite close in terms of the time it takes to rebuild any substantial part of our industrial establishment. Since we are talking here not essentially of new construction but things that have to be done to plants which exist at present, I think it would be a tremendous achievement if we even made this goal.

Mr. MACKENZIE. May I comment on this further, sir.

Mr. DADDARIO. Certainly.

Mr. MACKENZIE. I think one of the impediments to making more rapid progress than has been indicated in Mr. Cohen's statement relates to the existence and scope of activity of State and local government regulatory control activities. I would like to point out to the committee that not more than half of the urban areas which are in need of regulatory control programs for air pollution control now have them, and of these the majority of them are operated at an inadequate level to do the kind of job that you are inferring might be looked for.

On the State government level, it was only about 14 years ago, in 1952, that the first State set up a State air pollution control law and started operating a significant air pollution control program.

In the intervening period we now have about half the States that have significant laws on the books. But, only a handful of these are operating programs that are at an effective level. So that I think what is lacking as related to this goal is not so much the technology as it is the development of the control programs on the State and local levels of government that would effectively see that the available technology is employed.

Mr. DADDARIO. If that were to be done, what effect would it have on the percentage figures Mr. Ryan referred to?

Mr. MACKENZIE. Well, of course, in any of these, as was indicated by Mr. Cohen, necessarily there is a time schedule that is involved in effecting a rollback of pollutant emissions.

As an example, many of the major steel manufacturing centers in the country in the past several years have been confronted with the problem of controlling pollution from steel manufacture, and in the main this has required looking at the feasible design and construction periods that could be incorporated in the scheduling in order to effect the necessary improvements. In the majority of these centers this has led to agreed-upon schedules that would reduce the pollution from this source, which I am using solely as an example, over a period which varied from 7 to 10 years generally.

Now, this is significant progress but I think it needs to be pointed out that there isn't any valve that you can shut off that would stop the pollution. In the main it takes a significant time period to actually accomplish some degree of improvement. As a further example, in the field of pollution from automotive vehicles, we have issued standards that are obligatory on the manufacturing industry beginning with the 1968 model year. Now, with something over 80 million vehicles already on the road, the incorporation of controls on the 9 or 10 million vehicles that will come out in any one year is not going to result in a rapid change in the pollution emission picture from automobiles.

This will be a gradual change for the better and is reflected in the percentage improvement figures that were cited by Secretary Cohen. These factors, sir, limit what we think can be accomplished reasonably. We are hopeful that these actions can actually be accomplished, and if they come about, then I think we will be well on the road to significant improvement. I want to be not only hopeful about what we can do, but also realistic about what it is possible to accomplish.

Mr. RYAN. Well, if the political institutions were more advanced, I take it that technology could go ahead and develop the means to reduce air pollution by more than 25 percent in the next 10 years.

Mr. MACKENZIE. Yes, I think the limitation on our improvement is more of a political and social nature as of now, certainly with respect to pollution from stationary sources, than it is technological with some important reservations. The sulfur pollution problem is one in which there is a real basic need for improvement in technology.

Mr. MOSHER. Another major element certainly is the private investment that would be required. You are talking about steel plants. Isn't the capital investment——

Mr. MACKENZIE. Capital investment is relatively high but in terms of percentage of the total investment in the manufacturing plant, it is not great.

Mr. DADDARIO. Mr. Ryan?

Mr. RYAN. I would like to bring out one other point on this question of political institutions. It refers to the matter of air sheds and regional control. How much thinking has been done in terms of developing this on a nationwide grid pattern or something of that nature?

Mr. MACKENZIE. We have been endeavoring to sell this concept sir. In the Clean Air Act there is provision for additional financial incentive by grants for program development to State and local agencies when the regional concept is incorporated in the applicant's plans.

In this way, for example, on a program improvement project, the grant, instead of providing $2 of Federal money as is usual for most projects, would be increased by 50 percent for a regional project to make it $3 for each matching dollar by the applicant.

In spite of this, I frankly am personally disappointed at the extent to which this financial incentive has resulted in regional programs. I don't think it has been as effective as I had hoped that it might be.

Mr. RYAN. There you are leaving the initiative to the local governments and the regions. Has your Department or any agency of government given any thought to developing a national air shed grid so to speak, which would then be something that you could present to the Congress?

Mr. MACKENZIE. We have currently been operating on the directive that is included in the Clean Air Act that the primary responsibility for control of air pollution rests with the States and local governments. We think we need to give this a fair trial. If it does not result in the improvement that we think is desirable, we will come back and report so to the Congress and hope that the policy will then be changed.

Mr. VIVIAN. Will the gentleman yield a minute. I can appreciate his concern because I remember driving to his district, and by the time I got through the Holland Tunnel I was incapable of smelling anything.

Mr. RYAN. How much time do you intend to give the local communities and governments before you come forward with something that is a more nationally oriented plan?

Mr. MACKENZIE. Well, I wouldn't like to set down a definite time scale for this, Mr. Ryan, at this point. Under the terms of the Clean Air Act, however, in certain regional areas which are interstate in character, we are making studies for the purpose of determining whether or not more direct Federal action may be called for.

With respect to the New York City metropolitan area we have already initiated a Federal abatement action involving pollution which flows either way across the State line from New York to New Jersey or vice versa from New Jersey to New York.

We expect to hold the first formal conference in connection with this abatement action a little later this fall.

Mr. DADDARIO. So the techniques are developing in this direction?

Mr. MACKENZIE. Yes.

Mr. DADDARIO. Not as fast as we would like, apparently.

Mr. Brown?

Mr. BROWN. Mr. Chairman, could I explore a slightly different aspect of this? Perhaps this was touched on by Secretary Cohen, but is there any scientific discipline which is primarily concerned with the development or the progress in the field of waste management or pollution control which could be assisted in the same fashion that we provide assistance to other scientific disciplines? Is there a developing discipline in this single area? I recognize the fact that many disciplines contribute to it but is there something more specific that could be encouraged?

Mr. STERN. There is support provided by the Public Health Service both in the specific area of training for air pollution and in the more general area of environmental health which includes not only air but also aspects of land and water. Support is thus being provided both at the level which looks at all of these disciplines as a unit, and at the separate discipline.

In the particular area of air pollution we are supporting university training this year at 20 universities and in the coming fiscal year we expect to expand this to 38. This year we are supporting as either fellows, or by stipends from the university training grants, 159 fellows at university level air pollution training and this will be expanded this fiscal year to 268.

And, at our own training facilities in Cincinnati, where we have short-term training courses this past year we have trained about a

thousand people in 1- and 2-week training courses and we will expand this by 50 percent this year.

Mr. BROWN. Well, I would like a little more information on this. I know that in California we have the State government enter into certain contracts to make use of aerospace technology, the so-called systems engineering groups. One of these was a waste management contract. It went to a company which had no prior experience in waste management per se, but was loaded with systems engineers. So, I presume they brought in the specialists that they needed and attempted to construct in the brief study that they made, some sort of approach based upon their particular expertise. But, there's a very real problem in developing a specific scientific skill directly related to this. I know when Los Angeles County set up their air pollution control district, they brought in chemists, civil engineers, all sorts of people that they thought would have a background related to this, but none of them really had experience in the total problem of how you control air pollution in the sense that you have been talking about it here.

I think we need to encourage this sort of approach, and if necessary we need to look backward. It just occurred to me while you were talking, that in this country we have had some examples of very skillful waste management in very prosaic ways. For example, the Dutch farmers in Pennsylvania used to and probably still do, carry on a very fine type of agriculture based upon the fact that they don't waste anything. They compost the manure, they do everything necessary to build a closed loop out of their agricultural operation. And, we need this sort of an approach to our whole scientific technology or industrial technology today. I'm just wondering if we are making any approaches in this direction or if we need to encourage further approaches to additional training drafts and things of that sort.

Mr. STERN. This is the sort of approach that is being encouraged in these environmental health type of training grants which are being made to universities where the students are being given course work and do their research in an interdisciplinary area that unites and relates all of these problems, one to the other.

Mr. DADDARIO. Mr. Roush?

Mr. ROUSH. Mr. Chairman, although you indicated that the committee would be getting this I want to restate my own feeling that we should know the answer to several questions, pertaining particularly to specific information. For instance, we should know how much money is being spent by HEW to whom it is being allotted, how many people are involved, the nature of their skills, where the research is being done, a description of the work which is being done by HEW, by other Government agencies who are being financed with HEW funds, and by private institutions and nonprofit institutions carrying on work with HEW funds. Then, Mr. Chairman, I had a more specific question. I'm wondering how you bring together the information which is obtained by the various research projects being financed by HEW and various other governmental agencies. Is your office the clearinghouse for the bringing together of such information? (Information requested is contained in vol. II, under section for HEW.)

Mr. STERN. We have within our organization an Air Pollution Technical Information Center. This is the first of the governmental

type of technical information centers that are the result of the study by the Office of Science and Technology as to how governmental agencies should develop a technical information resource. Through this activity we attempt to maintain a central source from which people can get information on what is going on not only with governmental funding but also from any support, and to make it readily available to the public. We have had numerous publications and attempt as rapidly as information is obtainable to make it available by publication either in the form of technical papers that are published by technical societies, or of publication by our own agency.

Mr. ROUSH. I gather that industry is doing a great deal with the problem of air pollution. Is there a means of getting the results of their endeavors into this office so that it, too, might be made available to other industries and other users?

Mr. STERN. In cooperation with the principal technical association in this field, the Air Pollution Control Association, we jointly support the publication of what are called APCA abstracts—Air Pollution Control Association abstracts. We have contracted with the Library of Congress and with other agencies to obtain the basic literary resources and make them available so that they can be published. This includes information from industry sources as well as from governmental sources that are published either by this technical association or elsewhere in the world.

Mr. ROUSH. Is there any way that an industry which has a particular problem can direct its inquiry to you? They may say, "We are engaged in the manufacture of the following product and in the course of that manufacture we follow the following processes: We have an air pollution problem; and do you have information which would be helpful to us?" Can you answer that inquiry without sending them a pamphlet?

Mr. STERN. We have in addition to this Air Pollution Technical Information Center a fairly large organization known as our Technical Assistance Branch. This organization which has its headquarters in Cincinnati has been set up primarily to provide technical assistance to States, to cities, and to industry, and we have developed in this group expertise to answer most of the kinds of questions that cities, States, or industry ask with regard to air pollution.

Mr. ROUSH. Just one more question, Mr. Chairman. In your testimony you mentioned that Germany and Japan were taking certain steps to solve their pollution problems. Do we have a program whereby we can definitely benefit from the research which is being conducted in other countries?

Mr. MACKENZIE. Yes.

Mr. ROUSH. Is it sufficient?

Mr. MACKENZIE. I think we are fully cognizant of most of the significant work that is going on in the air pollution field elsewhere in the world. We have kept up on this by participation in a series of international organizations to the extent that we consider appropriate, and also through bilateral arrangements with a number of countries as well.

For example, we have cooperated with the World Health Organization by participation in their expert committees. We have also

assigned to the World Health Organization an epidemiologist from our staff to assist it in getting data from various countries that would be of interest to us and to other countries. The Organization for Economic Cooperation and Development, to which the United States is a party, has a group which is fostering cooperative projects in the air pollution control field in which members of our staff participate.

We have collaborated with the Economic Commission for Europe which is engaged in the development of certain types of standards relating to the control of air pollution.

We have a bilateral arrangement with West Germany in connection with studies relating to the control of air pollution, particularly from automobiles and from fuel combustion. This is being developed further.

We have a bilateral agreement with the Japanese through the Science Board which has a specific Committee on Air Pollution. There is a severe air pollution problem in certain parts of Japan and there are cooperative research projects that have been inaugurated under these auspices. We have assigned an epidemiologist to the Tokyo-Yokohama area for collaborative work in studies of the so-called Yokohama asthma which has been very bothersome to military personnel assigned in this area and is a troublesome problem also in the local population.

Mr. ROUSH. I would like to be exposed to it for about a week. I think it might be very helpful right now. Go ahead.

Mr. MACKENZIE. Well, I cite these as examples of our activities in the international field. They provide opportunities, in my opinion, that we should take advantage of in order to keep fully abreast of what is going on elsewhere in the world.

Mr. ROUSH. Thank you, Mr. Chairman.

Mr. DADDARIO. Mr. Vivian?

Mr. VIVIAN. On the subject of automobiles and pollution from automobiles, I get the impression from the Secretary's testimony that you see no solution on the problem of automobiles and air pollution therefrom except by replacement of the power system of automobiles by something other than an internal combustion engine. Is that a correct statement, sir?

Mr. STERN. I don't know as I would subscribe to that. I think there are opportunities for improvement in the internal combustion engine that we haven't fully explored. We really don't know the limits to which the present powerplant can be improved. We have some doubts as to whether it can be improved to the extent that we can double the number of automobiles without putting devices such as afterburners on cars. I wouldn't say at this time that we have written off the present form of engine as an impossible one for further improvement.

Mr. VIVIAN. You regard the fuel cell as a possible alternative source of power?

Mr. STERN. Yes.

Mr. VIVIAN. And if you have fuel cells will you not almost totally eliminate the problem except in the generating plants which generate the power in the first place?

Mr. STERN. We don't have enough experience with the exhaust products from fuel cells to know whether they might have objectionable

chemical substances in them which are manufactured in the fuel cell in the same way that the exhaust from an automobile has chemical substances manufactured in the combustion chamber.

Mr. DADDARIO. Mr. MacKenzie, you mentioned that these antipollution devices for automobiles relate to new cars. We have, however, had some experience in California. How has this worked out? Has the device, which I understand costs $50, been accepted by people? Do people recognize its worth? Has it gained wide enough acceptance so that buyers could be enticed to make this extra expenditure even for a used car or for cars already on the road?

Mr. MACKENZIE. The experience in California to date has not been as successful as the California authorities had hoped it would be with respect to the application of control devices to used cars.

The California law authorized a requirement for application of devices on used cars in accordance with standards and criteria that would be adopted by the California board authorities. Up to now, this has not been invoked except in a partial way about 2 years ago. That application involved a partial requirement for installation of pollution control devices on used automobiles specifically for the installation of so-called blowby devices intended to take care of the emission from the crankcase of an engine by recirculating this back to the intake of the engine where the emission is then burned as its goes through the engine again.

These devices are relatively inexpensive. They were estimated to cost not more than perhaps $15 each when installed on a used car. The experience in installation with them, however, through the private automobile dealers, the garage mechanics, and others that were involved, was not very happy—initially. Apparently almost everything that was possible to go wrong did, I guess. Consequently, the requirement for installation of devices on used cars in California is not currently being applied. It is still being given consideration and I believe, under the present law in California, if devices are certified by the board that will meet the State's standards and criteria, these can then be required on a schedule that would be set up by California authorities. To date, however, this has not been done.

Mr. DADDARIO. Mr. Stern, you touch on the very serious problem of air pollution as a cause of disease and ill health. I wonder what research is being done in developing devices to clean up the air immediately prior to inhalation, including such things as masks, home devices, and others.

Mr. STERN. There is work going on in the area of development of improved respirators. This is not a charge of our Department. Respirator certification is and has been for some time a responsibility of the U.S. Bureau of Mines who set the standards for respirators. However, we have been supporting by research grant studies at Harvard of improvement in respirator design and studies that relate to the form and fit of face masks and to the ease or difficulty in using a respirator—how much effort the individual must expend in breathing through a respirator. In buildings, of course, air filters are used as part of the means of cleaning air entering the building. Here certification methods have been developed by the U.S. Bureau of Standards. We have not been involved in methods of development or testing of air filters for buildings.

Mr. MACKENZIE. May I comment on this, Mr. Chairman?

Mr. DADDARIO. Yes.

Mr. MACKENZIE. We have considered it proper that our prime focus should be on the control of air pollution and not on means of personal protection by people. We would far prefer to take the course of maintaining the quality of the atmosphere so that it would be suitable for breathing purposes rather than resorting to and promoting any system by which people would have to go around with masks on. I cannot see this as a practical approach.

Mr. DADDARIO. I recognize that, but it is good to know that support is being given to this area of consideration.

(The biographical statement and complete prepared statement of Arthur C. Stern follows:)

BIOGRAPHICAL STATEMENT ON ARTHUR C. STERN

Educated Stevens Institute of Technology, Hoboken, New Jersey. M.E. 1930, M.S. 1933. Assistant Chief, Division of Air Pollution, U.S. Public Health Service, Washington, D.C., 1961 to present. Chief, Laboratory of Engineering and Physical Sciences, Division of Air Pollution, Public Health Service, Cincinnati, Ohio, 1955–1961. Assistant Clinical Professor, University of Cincinnati, 1959–1961. Chief, Engineering Unit, Division of Industrial Hygiene, New York State Department of Labor, 1942–1954. Directed New York City air pollution survey 1935–1938; Research for Smoke Abatement Research Endowment, Stevens Institute of Technology, 1930–1933. Chairman, American Standards Association, Sectional Committee on Industrial Ventilation (Z9). Member, American Society of Mechanical Engineers (Committee on Air Pollution Controls); member, American Industrial Hygiene Association (Air Pollution Committee); member, Air Pollution Control Association (Editorial and International Relations Committees). Diplomate, American Academy of Sanitary Engineers and American Board of Industrial Hygiene. Licensed Professional Engineer in Ohio and New York. Listed in Who's Who in America, Who's Who in Engineering, and American Men of Science. Editor of "Air Pollution" (2 Volumes), Academic Press, 1962.

PREPARED STATEMENT BY ARTHUR C. STERN, ASSISTANT CHIEF, DIVISION OF AIR POLLUTION, U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Mr. Chairman and Members of the Committee:

I am pleased to have this opportunity to appear before you and to review the adequacy of present technology for controlling the problem of air pollution in this country.

Air pollution, as recently as the early 1940's, was perceived as a relatively simple problem having to do with the emission of black smoke and cinders, and confined to a relatively few Eastern and Midwestern industrial cities. The technology for controlling this kind of air pollution consisted of improvements in combustion practices, restrictions on the kinds of fuel used, and in some cases, devices to control cinder emissions. When smoke became so intense in some cities as to bring on a public clamor for relief, this technology was applied and, with considerable help from the fortuitous change from steam to diesel powered locomotives and the substitution of gas and oil for coal in space heating, the atmospheres of these cities visibly improved.

Today, Mr. Chairman, as you are well aware, the air pollution problem is known to be much more complex than this, and its effects are infinitely more serious than was once suspected. Moreover, these effects are felt daily in every region of the country.

One of the principal reasons the contemporary problem of air pollution must be controlled is that we know that it adversely effects human health. The tragic episodes of acute air pollution have made it clear that in high concentrations over very brief periods of time air pollution can cause death and disability. In Donora, Pennsylvania, in October 1948, during a short period of temperature inversion and fog, approximately 6,000 persons became ill, out of a population of

14,000, and 17 persons died. Those present in the town during the period remarked on the heaviness of the fog, and on the intensity of the familiar odor of sulfur dioxide coming in large part from a local zinc roasting plant. Autopsies were performed on five of the dead; a common finding was acute irritative changes of the lungs.

In London, in December of 1952, the weather produced a pea soup fog and for a period of four days stilled the atmosphere to bring about an accumulation of pollutants. A few months later, when mortality statistics were reviewed, it was discovered that the city had experienced 4,000 excess deaths in a 7 day period which started with the first of the fog.

There have been other recorded episodes and some probably unrecorded. As recently as 1963, during a fifteen day period of acute air pollution in New York City, the average number of deaths exceeded the average number for corresponding periods in other years by 647. The combination of air pollution, cold weather, and influenza has been cited as the cause of the New York episode.

I would like to point out here, Mr. Chairman, that we have today no foolproof scheme by which we can predict the potential for an air pollution episode and on the basis of such prediction take timely action to prevent an episode. Virtually all our metropolitan areas and a great many industrial towns have the potential for an air pollution episode. They have the sources of pollution, and they experience to some extent the meteorological stagnations that cause pollutants to accumulate. The degree to which we can predict an air pollution episode depends not only upon our assessment of what will be discharged to the atmosphere some hours or days hence, but also upon the accuracy and reliability with which we can predict the weather at that time. Although the art of forecasting weather conditions conducive to the buildup of pollutants has been slowly but surely developing, this art has hardly been brought to the point where we can entrust it with our health and welfare.

At the present time meteorologists from the Environmental Sciences Service Administration of the Department of Commerce, on assignment to the Division of Air Pollution, forecast air pollution potential advisories daily. The areas covered by the individual advisories are at least 75,000 square miles, which is roughly the size of Oklahoma; and the lines defining the advisory areas are roughly 100 miles wide. The micro-climatic conditions prevailing in any particular communty depend upon a great many factors additional to those which produce these large scale anticyclones. While our Department, Mr. Chairman, has encouraged the States and local governments to use these air pollution advisories as one of the precautionary steps that can be taken to prevent mass tragedy, we consider this weather advisory activity only as supplementary to the control of air pollution.

Of even greater concern to us than the episodes of high levels of air pollution and their immediate effects are the effects on human health of long term exposures to low levels of air pollution, levels that routinely occur in virtually all of our metropolitan areas and in countless industrial towns throughout the United States. I would like to clear up any possible confusion on this matter of the health effects of chronic exposures to ordinary levels of air pollution. We are still accustomed to thinking that a disease state is brought about by a single cause—a carryover from public health history when almost total emphasis was placed on the bacterial or viral agent that had to be present before a particular communicable disease could be diagnosed. This postulate has served us well and continues to serve us well. However, the idea that one agent is wholly responsible for any one disease state cannot provide the solutions we need today in dealing with the increasing incidence of chronic disease. There is a considerable body of evidence which makes it unmistakably clear that air pollution is associated with chronic respiratory disease. Various studies have shown that death rates from cardiorespiratory causes correlate in general with air pollution levels. Other studies have shown that asthma attacks have correlated with variations in sulfate pollution and with the incomplete burning of refuse. One study demonstrated that persons living in a town where air pollution is high displayed significant differences in average airway resistance when compared with persons living in a town where pollution levels were lower. The result of laboratory studies involving exposure of animals, and in some cases humans, to controlled concentrations of ozone and sulfur dioxide agree generally with the results of these epidemiological studies. One significant investigation resulted in the development of lung cancer in laboratory animals infected with influenza virus

and later exposed to inhalation of an artificial smog of ozonized gasoline. These are but a few highlights of investigations that have been carried on and which indicate conclusively that air pollution is associated with the important chronic respiratory diseases of lung cancer, emphysema, chronic bronchitis, and asthma.

But this is not to say that air pollution is *the* cause or *the* agent which brings on any one or all of these diseases. There may be several agents. Chronic bronchitis, for example, which has been established in Great Britain as a specific disease entity, develops over a long period of time and may become crippling through a combination of many factors—air pollution, smoking, repeated bouts with infectious agents, occupational exposures—all affected, perhaps, by hereditary predisposition. The point is, Mr. Chairman, whether we call air pollution one of sveral causes or name it as a contributing factor, the evidence is abundantly clear that air pollution is a hazard to health.

As Undersecretary Cohen has pointed out, there are many cogent reasons why we must control air pollution. But by far the most compelling reason, the principal reason why the American public and its representatives have demanded that we restore the atmosphere, is that air pollution contributes to illness and death.

Just as our perception of the nature of the air pollution problem has changed drastically in the past few decades, so has the problem changed, and so has our ability to deal with it changed. In 1955 when the Federal air pollution program was initiated, there was little exact knowledge of the kinds and quantities of pollutants in the air, or of the mechanisms by which they accumulate or are dispersed. The National Air Sampling Network and the Continuous Air Monitoring Program, both operated by this Department have since gathered extensive data on the amounts and chemical composition of particulates in the air, and the concentrations of such gaseous pollutants as nitrogen dioxide, nitric oxide, carbon monoxide, oxidants, total hydrocarbons, and sulfur dioxide. Advances in meteorology have enabled us to gage the atmosphere's total mixing or absorptive capacity over a particular geographic region, and thus to estimate the degree of air pollution control needed for a given area.

The technological means of controlling the sources of air pollution have also been rapidly developed in the past several years. Particulate pollutants can be removed by devices which employ principles of filtration, electrostatic precipitation, or centrifugal force. Gaseous pollutants can be taken out through liquid scrubbing, vapor recovery, combustion, and solid absorption. Open burning once widely employed to dispose of a city's trash and to get rid of leaves, upholstery in scraped automobiles, battery cases, tires, etc., can and has been in some cases replaced by processes which do not pollute the atmosphere. Smoke pollution from domestic, commercial and industrial incinerators, boilers, and heating systems can be largely eliminated through improved fuel burning equipment and proper firing practices. Carbon monoxide and unburned hydrocarbons discharged from the gasoline powered motor vehicles have been brought under partial control. In fact, through control devices or through process modification most sources of air pollution in the United States today can be brought under control.

It seems to me, then, Mr. Chairman, that we have two fundamental realities to face concerning the problem of air pollution in the United States today. First of all, air pollution is today a major problem in this country. It not only costs the country billions of dollars each year in agricultural losses, transportation delays, and material and structural damage, it contributes in a very real way for most Americans to the incidence of disease and the premature occurrence of death. Further, all the major trends of growth in our society—increasing population, increasing urbanization, increasing industrialization, increasing use of fuels, increasing use of motor vehicles—all project a severely worsening air pollution problem in the near future. The 1965 population of 195 million is expected to swell to 250 million in 1980. A larger percentage of this larger population will be living on roughly the same land area presently occupied by our current urban population. The gross national product, probably the best indicator of our overall economic activity and therefore the best indicator of the demands on our environment, is expected to climb from the 1965 level of $650 billion to $1010 billion in 1980. Last year's fleet of 85 million motor vehicles is expected to climb to 120 million in 1980. And our present discharge to the atmosphere of the United States of roughly 24 million tons of sulfur dioxide will, if present trends continue, soar to almost double that amount, or 43.6 million tons by 1980.

The other reality we must face, Mr. Chairman, is that in spite of the fact that we presently have the technology for controlling most sources of air pollution, we are not by any means applying that technology in adequate measure. The Clean Air Act and its amendments have stimulated an unprecedented expansion in the efforts to control air pollution in this country. Totally, including both Federal and non-Federal contributions, the funds available for State and local air pollution control programs have increased by about 65 percent since the adoption of the Act in 1963. On an annual basis, some $20 million is now being invested in State and local programs as compared with $12.7 million in 1963. As a direct result of Federal grants, efforts are now being made which, if successful, will bring a total of 70 new air pollution control programs into being. In addition, 40 existing agencies are improving their programs as a result of Federal grants. The Federal Government has initiated interstate abatement actions that will ultimately benefit millions of people; we have published standards which will bring all new automobiles under partial control commencing with the 1968 model year; we have stepped up our research efforts and have progressed toward the control of gaseous pollutants that once were clearly beyond our reach. In all parts of the country the public is demanding better control efforts at all levels of government, and there is no question that these demands will accelerate. But we have a very long way to go. Although 33 States now have air pollution programs, many of them have neither the authority nor the resources needed to carry on effective control activities. Only a half dozen State agencies engage in more than a nominal degree of abatement activity, and by far the great majority of States are not even serving those communities which are too small to operate their own local programs but are nonetheless affected by serious air pollution problems. For the most part, efforts at the local level are equally deficient. Our most recent estimate indicates that only 58 percent of the urban population of the United States is served by local air pollution programs. On a per capita basis, annual spending for local programs has increased from a median figure of 10.8 cents to 15.2 cents. This increase is hardly adequate in the light of estimates that an effective control program for a middle-sized city requires an expenditure of at least 40 cents per capita.

Mr. Chairman, I have presented this, perhaps long, introduction on the problem of air pollution because I want to strip away any possible misconceptions of what our basic needs are in coming to grips with the problem. The problem of air pollution has grown so enormously in such a relatively short period of time that we have found ourselves rather suddenly confronted with, if you will, an enormous aid pollution gap. Let there be no mistake about it, that gap fundamentally is the application of controls to the sources of air pollution. The activities carried out under the Clean Air Act have stimulated all levels of government, industry, and the public to exert greater efforts in bridging that gap. But we have barely started. The problem of air pollution continues to grow faster than the combined Federal, State, and local efforts to deal with it. President Johnson summed it up in his February message to the Congress on Preserving Our Natural Heritage:

"The Clean Air Act of 1963 and its 1965 Amendments have given us new tools to help attack the pollution that fouls the air we breathe. We have begun to counter air pollution by increasing the tempo of effort at all levels of government. . . . I am heartened by the progress we are making. But I am mindful that we have only begun our work."

We recognize, Mr. Chairman, that the Federal Government must assume leadership in this field, but the Federal Government cannot alone do the job. State and local government and industry must assume additional responsibilities in controlling air pollution, and the public must be more fully informed of the very real hazards associated with air pollution. The pressure of public opinion must be brought to bear against the indiscriminate discharge of pollution into what is unmistakably in the public domain, the atmosphere. In short, Mr. Chairman, the course is clear. We must now and in the immediate years ahead greatly accelerate our efforts to control the sources of air pollution. We have very real social and economic incentives, we have the governmental framework through which we can get at the problem, and we have the technology with which we can in large measure bring the problem under control.

None of this is to say that we can afford to be complacent about the presently available technology for controlling air pollution. There are some pollutants, like the nitrogen oxides, which today, rarely, if ever reach what are thought to

be harmful levels in many regions of the country. We do not have adequate technology for controlling nitrogen oxides.

There are some pollutants, like the sulfur oxides, which today almost constantly reach harmful levels in most of our metropolitan areas, and the increasing use of sulfur bearing fuels for energy and other purposes will undoubtedly aggravate this problem in the years ahead. We have reached the prototype stage in one approach to controlling the sulfur oxides, but for the most part we can control sulfur pollution today only by using low sulfur fuels. There are some sources of pollution, like the automobile, whose emissions we can today partially control, and the Federally required national application of this control to new cars in the fall of next year will be a significant step in halting pollution from the motor vehicle. But the rapidly increasing number of automobiles will in the next two decades wipe out the gain from today's partial controls. Further, Mr. Chairman, we can not be complacent about the attractiveness of much of the technology for controlling air pollution. Pollution controls generally do not increase the efficiency of industrial production or improve the quality of the product. In fact, since in our marketplace the focus is on minimizing costs and maximizing returns, present day pollution controls, which add to costs and not to returns, are frequently considered an impediment by those who operate the sources of pollution. We can expect that this attitude will prevail as long as regulation of pollution varies from place to place, or until the technology of pollution control is developed to the point where control is not considered to be an economic impediment by industry.

I would like in the remainder of my statement, Mr. Chairman, to review in some detail the current adequacy of technology for controlling air pollution, and to describe the efforts the Federal Government is making to advance this technology.

MOTOR VEHICLES

Certainly one of the major sources of air pollution in this country is the gasoline powered motor vehicle. Today's motor vehicle discharges four significant pollutants to the atmosphere: carbon monoxide, which is a toxic gas; hydrocarbons, which in the presence of sunlight react with nitrogen oxides to form photochemical smog, which in turn has been widely observed in its damage to plants and its irritating effects on the eyes; the nitrogen oxides, which not only contribute to smog but which in high enough concentrations are hazardous themselves; and lead, which is receiving increasing attention by the Public Health Service of this Department and others because of the possibility that, even in very low concentrations in the environment, lead may have adverse effects on certain segments of the population.

Thee are four sources of emission in conventional motor vehicles: the tailpipe, which is the most important source of hydrocarbons and the only significant source of nitrogen oxides, carbon monoxide, and lead; the crankcase, which receives unburned hydrocarbons blown by the engine pistons and which until recent years vented to the atmosphere through a tube; and the gas tank and carburetor, both of which permit hydrocarbons to evaporate to the atmosphere.

Under the 1965 Amendments to the Clear Air Act Secretary Gardner has issued emission standards for all new gasoline-powered automobiles and light trucks sold in the United States commencing with model year 1968. These standards require 100 percent control of crankcase emission, and limit the concentrations of hydrocarbons and carbon monoxide that can be discharged from the tailpipe. The standards apply for the life of the vehicle, which is defined as 100,000 miles.

Crankcase blow-by can be burned by returning it to the engine intake system. This practice is not new to European car makers and has been used for years in America on certain special-purpose vehicles. There are variations in design: some return the blow-by to the dirty side of the air cleaner, others to the clean side, and still others to the intake manifold through a variable-orifice metering valve. A further variation, now required in California, consists of dual return paths of blow-by gases—to both the intake manifold and the air cleaner.

The principal approach to controlling tailpipe emissions is through engine modification. In meeting the Federal standards on tailpipe emissions, all but one of the country's car makers is expected to us what has been termed manifold air oxidation. Air is introduced under pressure to the exhaust manifold near each exhaust valve. This additional air at this high temperature location oxides some of the unburned exhaust hydrocarbons and some carbon monoxide. The system is accompanied by minor changes in carburetion.

The other type of engine modification system is achieved by a combination of the following changes:

(1) Leaner carburetor calibration under idle and road load conditions. The leaner fuel-air mixture promotes more complete combustion.

(2) Slightly earlier choke release. Since time is reduced during which a rich fuel mixture is fed to an engine, the amount of unburned hydrocarbon exhausted is reduced.

(3) Increased closed-throttle air flow. This provides a leaner mixture while idling.

(4) Retarded ignition at idle. This provides more complete combustion of the leaner idle mixture and minimizes the effect of increased air flow on idle speed.

(5) A vacuum advance control valve. Retarded ignition timing produces increased hydrocarbon emission during deceleration. The control valve senses the higher manifold vacuum associated with deceleration and advances the timing to normal.

None of these engine modifications decreases the emissions of oxides of nitrogen. Some may even increase them. Complete combustion of the hydrocarbons produces higher combustion temperatures; and the higher the combustion temperature, the greater the oxidation of the nitrogen in the combustion air. This Department is currently carrying on intensive research on the control of nitrogen oxides, and we expect that development of controls will progress so that nitrogen oxide emission standards can be established for 1970 model year vehicles. Two specific techniques now under study are exhaust gas recirculation and water injection, both of which reduce peak combustion temperatures.

Another approach to automotive pollution control is through afterburners which oxidize the products discharged from the engine exhaust. Both catalytic and direct flame afterburners were intensively developed primarily by automotive accessory manufacturers, to meet the 1959 California standards for emissions of hydrocarbons and carbon monoxide. By June 1964 three catalytic afterburners were approved for use on new cars in California and one direct flame afterburner was approved for use in both new cars and used cars. The approval by the California Board of more than one afterburner for new cars triggered a requirement that the majority of 1966 model year cars sold in California meet the standards adopted in 1959. Shortly after the standards were triggered, the automobile manufacturers announced that their high volume production 1966 cars to be sold in California would meet the standards through engine modifications, and the new car market for afterburners in California was essentially destroyed for the time being.

This market situation for afterburners can be changed by any of several happenings. First, the approval by the California Board of a second afterburner for used cars would trigger the requirement for their installation on most used cars in the State. Second, the necessity of meeting more stringent exhaust standards than the present ones may cause afterburners to become more competitively attractive to the auto makers, either in addition to or instead of engine modification. Third, the prospect, in the not too distant future, of standards for oxides of nitrogen in the exhaust should cause a second round of development of catalysts that will remove these oxides. If the ultimate route to oxides of nitrogen abatement is by catalytic reduction, it becomes more attractive to build oxidation catalysts for hydrocarbon and carbon monoxide removal into the same device. Lastly, the elimination of lead from gasoline could conceivably result in an afterburner which would last the life of the car or at least that of the other components of the engine exhaust assembly. A device which has this life, and which combines an oxide of nitrogen reducer and a hydrocarbon and carbon monoxide afterburner, and which is attached to the exhaust manifold of an engine having modifications to reduce pollutant emissions, should continually provide an emission essentially free of all the principal exhaust pollutants. That would be a combination hard to beat.

Fuel modification is being studied as a means of lowering hydrocarbon emissions. However, the only regulation of fuel composition in the United States intended to abate automotive emissions is a Los Angeles requirement that no gasoline may be used which has a degree of unsaturation greater than Bromine Number 20. This limits the olefin content of gasolines; certain olefins are more active than other components in producing photochemical smog. The drawback to this regulation is that the automobile engine cracks gasolines to produce olefins even if olefins are not originally present in the fuel.

Any change in fuel composition which would provide the required octane ratings without alkyl lead additives would make possible lead-free exhaust. There is no national regulation in the United States limiting the quantity of alkyl lead additives in gasoline. However, there is a voluntary agreement between manufacturers of lead additives and the Public Health Service as to the maximum lead content of gasoline; this is at present 4.0 milliliters per gallon (TEL).

Evaporative losses from gas tanks and carburetors occur because these customarily have vents to the atmosphere. Evaporative losses from the carburetor are of two types, vent losses during vehicle operation, and what are called "hot soak" losses, which occur after the engine has been turned off and the rise in temperature of engine parts under the hood causes evaporation of gasoline stored in the carburetor bowl. Losses during vehicle operation have been substantially reduced during the last several years by the elimination of external vents from most carburetors. Those carburetors that vent externally do so during closed throttle operation to facilitate hot starting and to reduce fuel mixture enrichment during conditions of high temperature. An experimental system for control of "hot soak" losses pumps the fuel remaining in the carburetor bowl back to the gas tank after the engine has stopped. Since the bowl is empty when one wants to restart the car, there is an objectionable delay in starting which has to be overcome before this approach to control becomes acceptable. Such systems are not yet on production vehicles.

If there were no vent to allow air to enter the gas tank as fuel is consumed, tanks of normal construction would collapse because of the vacuum created inside; conversely, when the engine is off, a temperature rise would cause an increase in tank pressure. Since this tank overpressure is small, compared to the previously mentioned tank vacuum, a solution is the use of a one-way valve, which will let air into the tank but prevent vapor outflow over a moderate range of tank pressurization. The valve opens as a safety valve in the event of an overpressure high enough to impair the integrity of the tank. Such a valve, built as part of the gas tank filler cap, has been used experimentally and, in conjunction with insulation of the fuel tank, has been effective in reducing fuel tank evaporative losses. The safety, under accident conditions, of tanks so equipped has not been evaluated. This system is not in use on any American cars.

Another approach to the control of evaporative losses is through the reduction of the volatile components in the fuel. Studies are presently underway to determine the feasibility of this approach, both from the point of view of the effectiveness of control and of the effects on fuel characteristics.

The automotive pollution control measures so far described, Mr. Chairman, can be applied today or in the very near future. For the long haul, it would appear that add-on devices and minor engine modifications will ultimately fall short of the desired degree of abatement, so that research on fundamentally pollution free engines is also needed.

One means to achieve lean-mixture operation which results in more complete combustion and, therefore, in less pollution, is through the use of stratified charge techniques. Stratified charge operation presents to the spark plug at its firing time a small preliminary "starter dose" of rich fuel-air mixture which is easily ignited and propagates its flame to the rest of the fuel-air mixture, which might otherwise be too lean to be ignited by the spark plug. This method permits an excess of oxygen to be available for more complete combustion without affecting the efficiency of ignition. To achieve this type of operation, cylinder heads and combustion chambers would have to be redesigned.

The gas turbine engine is one of several potential alternatives to the conventional piston engine as a power source for motor vehicles. Chrysler Corporation, which is conducting extensive research and development in this field, made a prototype turbine car available for testing by the Public Health Service of this Department for a two-week period in April and May 1965.

The tests were focused mainly on the most common and best known classes of pollutants produced by internal combustion engines. They showed that hydrocarbon and carbon monoxide emissions from the turbine car were far lower than those from a comparable piston-engine model. In terms of pounds of pollutants per mile of driving, the turbine car emitted only 15 percent as much hydrocarbons and only 10 percent as much carbon monoxide. Nitrogen oxide emissions were also lower, but only slightly.

A potentially important advantage of the turbine car, with respect to air pollution, is its ability to burn low-grade, non-leaded, fuels, including kerosene.

From the standpoint of air pollution, the only marked disadvantage noted in these tests was that the turbine engine, when it was fueled with kerosene, produced an odor similar to that from diesel engines; however, the odor was not severe.

It is important to note that these tests do not represent a full evacuation of the turbine engine's potential for contributing to communiy air pollution. As previously noted, only one vehicle was tested and the testing was focused on well known motor vehicle pollutants. No attempt was made to determine whether turbine engines produce significant amounts of lesser known or hitherto unknown classes of pollutants. Because there is often a substantial degree of variation in emissions from individual cars of the same general type, the fact that only one turbine car was tested must be kept in mind. The results are believed to be representative of this type of engine, but data to confirm this are not available.

Insofar as can be determined from available information, the outlook for the use of turbine engines—at least in trucks and buses—is essentially the same as it was in 1962 when, in a report to the Congress, the Surgeon General of the Public Health Service said: "There is no doubt that the turbine will find application for a number of purposes where its advantages are clear-cut. This includes fire engines and other emergency vehicles. For pulling one or several heavy trailers over turnpikes and interstate highways, turbines are unquestionably superior power plants."

The prospects for using gas turbine engines in passenger cars have generally been considered less promising, pricipally because of their relatively high fuel consumption and their lag in providing acceleration from a standing start. In recent weeks, however, the Chrysler Corporation has taken a more hopeful view, at least in its statements to stockhoders and the public.

On April 19, Chrysler announced development of a second-generation turbine engine which will serve as the basis for its future work in this area. The new model was said to overcome, to an unspecified degree, the disadvantages of the earlier prototype. Air pollution data for the new model have not been released. Chrysler is the only major automobile manufacturer known to be involved, to any appreciable degree, in efforts to develop turbine powered passenger cars. Both Ford and General Motors are known to be actively engaged in the development of turbine powered trucks.

The need to control emissions from diesel engines is still another important aspect of the problem of motor vehicle pollution. Although less than 0.5 percent of our vehicles are diesel powered, from the standpoint of someone driving behind a diesel bus or truck, the need to control diesel emissions may well seem the most important. I suspect that no other aspect of the problem makes so many people so indignant or so uncomfortable on so many occasions. The smoke and odors that come from diesel engines are, by any standard, an obnoxious nuisance; moreover, diesel engines contribute to community air pollution in other less obvious ways, as well.

In a diesel engine, tailpipe exhaust emissions comprise almost 100 percent of the total emission. Hydrocarbon emission amounts to about 2 percent of the supplied fuel. Both hydrocarbon and carbon monoxide emission from diesels are well within the present Federal standards set for new gasoline powered vehicles. However, because the extremely high diesel exhaust flow rate offsets lower concentration values, the pounds per hour rate of hydrocarbon emission from a diesel is close to that from an equivalent gasoline engine. Evaporative losses are nil because diesels have a closed system of fuel injection and diesel fuel is less volatile than gasoline. Crankcase emission losses are zero for two-cycle engines because blow-by past the piston becomes mixed with the inlet air for the next stroke. On the four-cycle engine, crankcase emissions are not over 0.05 percent of the fuel or over 2½ percent of tailpipe emissions. Nitrogen oxides emissions are substantial and are comparable to those from gasoline engines.

Catalytic afterburners and fuel additives for the control of diesel smoke and odor have undergone limited tests. Results indicate a worthwhile reduction in these emissions but, before such devices and additives can be considered on a broad scale, more comprehensive studies are required.

The Amendments to the Clean Air Act provided authority under which the Secretary of Health, Education, and Welfare can establish national standards for the control of diesel emissions. A number of technical problems relating

to the control of diesel emissions must be resolved before controls can be established. To this end, we are pursuing studies in the area of diesel control technology and on the establishment of appropriate control standards.

Since no let-up is in sight in the worldwide increase in the number and use of motor vehicles, we must investigate all possible approaches to controlling the problem of vehicular emissions. These may include possible replacement of the internal combustion engine with alternative power sources, such as fuel cells or electric batteries; and alternative means and patterns of transportation in and between our biggest cities, such as rapid transit lines.

POLLUTANTS FROM STATIONARY SOURCES

I have indicated, Mr. Chairman, that the ubiquitous motor vehicle is an important source of air pollution in the United States today. Of no less importance, of course, are those stationary sources of pollution which multiply in our cities and towns to meet the ever increasing demands for goods and services. In treating these stationary sources of pollution, I would like to review in general the technology for controlling some of the more important classes of pollutants, and to review in more detail the status of control techniques in some of our larger industries.

Emissions from stationary sources can be conveniently separated into two categories—particulate and gaseous emissions.

Problems of particulate emissions readily lend themselves to control by the application of already proven techniques. Consequently, industry sponsored work has been primarily devoted to improving the efficiency of proprietary control equipment. Basic research and development is needed to improve both the efficiency and the capabilities of existing devices through better understanding of the principles involved.

In the area of electrostatic precipitation, manufacturers are devoting their research and development almost exclusively to hardware development. The principal exception to this is work which is being pursued to learn more about precipitation mechanisms at high temperatures and under high pressure. Studies of fabric filtration at the higher temperature ranges are also being conducted. An area which has received some industry-sponsored basic research attention, and an area in which research and development is badly needed, is that of small particle agglomeration. For the most part, the industry efforts are aimed at the development of proprietary devices which employ sonic or thermal treatment, or condensation, to agglomerate submicroscopic particulate which can then be removed by conventional collection equipment.

Much of the work which has been done to date in the area of particulate control device development has been confounded by the lack of uniform criteria for data evaluation and equipment performance.

Because of the variety of problems and the unique characteristics of individual pollutants, the area of gaseous industrial emissions has presented a much more difficult control problem than that of particulates. Control of gaseous pollutants is typically effected through process improvement or through recovery of gaseous emissions by chemical reaction. While control of most gaseous air pollutants is possible, the economics of accomplishing the desired degree of control has generally been considered a problem. Recognition of this problem, plus the potentially more serious nature of gaseous pollution, has stimulated more research and development activity in this area than in the area of particulate control.

In general, considerable work is needed on gaseous pollution control systems to close the economic gap between possible and practical control techniques. Both basic research on systems and studies of operating variables are needed to reduce investment and operating costs before they can be practically applied. Of the presently available control equipment, the versatility of wet scrubbers to cope with both particulate and gaseous emissions places high priority on the need to develop chemical reaction processes for gaseous pollution control. This method has its greatest potential in low volume emissions.

Proper control of industrial process variables has been demonstrated as an important means for control of air pollution at the source of emissions. This includes such processes as control of excess air and flame temperatures in combustion processes, and reactant ratios and concentrations in chemical reactions. Additional research by both governmental and industrial agencies is needed to exploit this approach for an air pollution control technique.

I would like at this point, Mr. Chairman, to focus specifically on the problem of pollution of the atmosphere by the oxides of sulfur. The presence of the oxides of sulfur in the atmosphere and their deleterious effects on health and welfare can be detected in virtually every part of the United States. In the next several years the problem can only worsen unless available means of alleviating it are used to the fullest extent, while at the same time the development and application of control technology are accelerated.

The principal source of sulfurous pollution is in the combustion of sulfur bearing fuels, and in the Clean Air Act the Congress has specifically called on our Department for research on the removal of sulfur from flue gas and on removal of sulfur from fuels.

Considerable worldwide effort has been devoted to the development of low cost techniques for removing sulfur from flue gases, and some progress has been made.

In Germany, the emphasis is on a process that uses activated carbon to adsorb the sulfur oxides from the flue gas. In Japan, one process under development first catalytically converts sulfur dioxide to sulfuric acid and then to ammonium sulfate; another process chemically reacts the sulfur oxides into a regenerable manganese sulfate. In Czechoslovakia, an ammoniacal washing process, which yields ammonium sulfate as the end product, is under consideration. Because of their immediate application to existing power plants, in all these countries and in the United States there is interest in processes which react alkaline materials with sulfur oxides to produce solids which can then be removed through filtration or precipitation. The Department of Health, Education, and Welfare has a contract with Battelle Memorial Institute to study sulfur fixation by lime and magnesia to elucidate the thermodynamics and kinetics of the reactions involved. Past efforts to remove SO_2 from combustion gases by reacting the SO_2 with alkaline materials such as limestone and dolomite have been handicapped by our inability to inject these materials into power boiler systems with assurance of good reaction efficiency.

In the United States two processes have reached the pilot plant stage. The first of these is an alkalized alumina process for scrubbing sulfur dioxide from stack gases and recovering the sulfur in acid or elemental form. The Department of Health, Education, and Welfare has transferred funds to the Bureau of Mines for the development of this process. In 1967, the operation of a larger, continuous alkalized alumina pilot plant will provide more reliable data on the performance and life of the absorbent and will reveal the parameters affecting SO_2 removal over a prolonged, continuous period. Work will begin on the preparation of absorbents which will resist attrition and lead to longer life and cheaper operation. New and more efficient methods of regenerating the absorbent will be investigated.

The second process to reach the pilot plant stage in the United States is a catalytic oxidation process which is being developed by private industry. The key to economic operation of this process lies in the recovery of the acid in a concentration of commercial value and at a high enough temperature to prevent corrosion of process equipment. The feasibility of various high-temperature acid recovery systems must be studied and related equipment-corrosion testing performed.

In both the United States and Japan, processes employing manganese oxide as an absorbent are being considered for removing sulfur oxides from stack gases. The difference in the processes lies in the method of regeneration of the absorbent. In the Japanese process, the absorbent is regenerated chemically to form calcium sulfate. The American process regenerates the absorbent electrolytically and yields a dilute sulfuric acid. Both of these products are of lower commercial value in this country than other possible sulfurous end products. Therefore, the economics of these processes would be improved if regeneration systems were devised to yield more desirable products at lower cost. A Department of Health, Education, and Welfare project for Fiscal Year 1967 is designed to find such means of regeneration.

Research into methods for desulfurizing fuels has been primarily concerned with residual oil and coal. The technology of the removal of sulfur from oil and gas is well known and extensively utilized in producing the almost-sulfur-free gas, gasolines, lubricating oils, and light fuel oils that constitute the bulk of the products of the oil and gas industry the world over.

Although an equivalent technology exists for desulfurizing residual fuel oil, its cost, as a percentage of the selling price of the product, has been so high as

to discourage its employment. New American refineries avoid the problem by producing no residual fuel oil; they produce instead liquid and gaseous products in the almost-sulfur-free category, and a high-sulfur-content solid residue, petroleum coke. However, since this option is not attractive to refiners in countries which lack our demand for gasoline and light fuel oil, and which export high-sulfur residual fuel oil to the United States, and since older domestic refineries still produce this product, there is still need for research to develop lower-cost methods of desulfurizing heavy fuel oil.

A start has been made with respect to this problem. Under a contract, the Bechtel Corporation investigated the cost of reducing the sulfur content of certain residual fuel oils to one percent. The most important conclusion from this study was that the manufacture of low-sulfur residual fuel oil from high-sulfur crudes requires an incentive pricing of 40 to 65 cents per barrel above fuel oil produced without sulfur restriction. This cost is increased about 20 percent if applied to an existing refinery. Further alternatives in the refining operation are being explored to lower, as cheaply as possible, the sulfur content of residual oil to 0.5 percent.

The technology of the removal of sulfur from coal is not well developed. It is known that coal-washing processes which lower the ash content of coal also lower its sulfur content to the extent that sulfur is associated with relatively large pieces of ash-substance. However, the bulk of the sulfur is more intimately associated with the coal substance and is released only by grinding and extraction processes which are presently relatively expensive. Research is needed both to lower the cost of these processes and to seek new ones. For years the needs for low-sulfur-content coal have been met from naturally occurring low-sulfur-content seams. Incentives for the development of coal desulfurization processes are of recent origin, too recent for a significant research effort to have developed.

However, studies of the forms and of the washability of sulfur in coal used in powerplants have been undertaken, and analyses of the ability of various commercial processes to remove sulfur from powerplant coals are being made. Preliminary studies of new processes for removing sulfur from coal have been made; they include air elutriation, thermomagnetic or electrostatic forces, and corona discharge.

Important as it is, Mr. Chairman, for us to vigorously pursue research and development of methods to remove sulfur from fuels and from combustion products, we must bear in mind that there are other measures which can be taken now to alleviate the sulfur oxides problem. These measures involve increased use of fuels whose sulfur content is naturally low, or locating large fuel-burning installations, such as electric powerplants, at considerable distance from large cities, and using tall chimneys.

There is no doubt that low-sulfur fuels are available in this country, but it has been only recently that government and industry have begun to examine the extent to which such fuels might be channeled to urban areas where sulfur oxide pollution has already reached serious proportions.

The construction of very large electric generating stations adjacent to coal mines is being stimulated by both economic considerations and air pollution factors. Unquestionably, construction of mine-mouth plants with very tall stacks in relatively sparsely populated areas helps to prevent the worsening of sulfur oxide pollution that would have resulted from their construction in urban areas. However, the very large size of mine-mouth plants, from which significant pollution may extend out 25 miles or more causes concern because of the possibilities of exposure of small communities and of causing extensive damage to vegetation. For such large installations, with stacks 800 to 1,000 feet high, technical estimates of ground-level pollution concentrations are subject to some uncertainty. Consequently, it is our present opinion that such plants should be limited to about 2,000 megawatts (when burning coal of about 2.5 percent sulfur) until actual measurements can be made to assess the validity of such estimates.

The increased availability of natural gas—which is essentially sulfur-free—offers still another opportunity for reducing air pollution arising from the combustion of high-sulfur fuels. The use of natural gas for domestic heating is already making a significant contribution to control of air pollution. Its increased use in electric powerplants in places with serious pollution problems could result in significant reductions in sulfur oxide pollution and in the seri-

ous threat that such pollution poses to public health and welfare. Such use, of course, must be considered in relation to the relative scarcity of natural gas as compared to other fossil fuels.

TECHNOLOGY OF CONTROL FOR INDIVIDUAL INDUSTRIES

Mr. Chairman, I would like now to turn to the specific problems of individual industries.

The first of these, petroleum refining, employs a wide variety of processes such as distillation, catalytic cracking and hydrogenation to produce gasoline, kerosene, and fuel oil, etc., from crude oil. Currently supplying 72 percent of the Nation's fuel energy, the crude oil processed is expected to expand from 10 million barrels daily in 1960 to 14 million barrels daily in 1975.

Principal refinery pollutants include hydrocarbons, sulfur dioxide, carbon monoxide, particulates and a host of odorous gases. Estimates made in 1963 place sulfur dioxide yearly emissions at 1,583,000 tons or nearly 7 percent of the total SO_2 tonnage emitted to the United States atmosphere.

For the most part, effective technology for refinery air pollution control exists today, having been developed largely in Los Angeles County to meet stringent air pollution control regulations. For example, injection of steam into flare lines has promoted complete, smokeless combustion of volatiles and vapors, replacing the familiar black plume so often associated with refinery flares. Sulfur dioxide and hydrogen sulfide emissions have been reduced by sulfur recovery processes that react the two gases to form elemental sulfur. The process yields salable recovered sulfur, which is then used for sulfuric acid manufacture.

Through concerted control efforts, petroleum refineries in the Los Angeles area have achieved a reduction of better than 80 percent in hydrocarbons, sulfur dioxide and particulate emissions. Most of the nation's more than 300 refineries, however, do not approach the levels of control in Los Angeles County, largely because of their unwillingness to make comparable investments in air pollution control equipment elsewhere. To comply with Los Angeles regulations oilmen estimate it would add 5 to 10 percent to the cost of a new refinery. Some of this expenditure would be returned from the sale of valuable products recovered. Current control equipment expenditures represent $18 million annually, of which 44 percent is spent on the West Coast. Total capital expenditures for United States refineries are greater than $350 million yearly.

The complexity of operations in a petroleum refinery creates many sources of pollutant emission. Tank vents, pulp glands, and leaking valves are sources throughout the refinery. Many industries can solve their air pollution problem by installing a simple collector on a single discharge gas stream. This is not so in a refinery. Effective control of pollution from a refinery must include proper housekeeping, process change, process control and emission control equipment.

In a second major industry, iron and steel, generally speaking all new proccess equipment being installed, except coke ovens, provide reasonably effective particulate emission control. High efficiency collectors such as electrostatic precipitators, venturi scrubbers and fabric filters are generally being installed on new potential major sources of pollutants. Such sources include sintering machines, blast furnaces, basic oxygen furnaces and electric furnaces. Some of the new equipment is replacing old equipment which, in the past, generated much air pollution. Although this method of bringing about a reduction in air pollution is slow, it does promise to eventually eliminate pollution from Bessemer converters and open hearth furnaces since there are, generally speaking, no new units of these two types of equipment being installed, and existing units are being taken out of service.

Exhaust gases from new and existing blast furnaces are used within the steel mills as fuel for other processes. By necessity these gases are cleaned prior to combustion so that in most installations few pollutants escape. Periodic, high rate emission resulting from "slips," which were formally a source of considerable pollution in blast furnace operation, have been minimized due to the use of sintered and classified charges.

The relatively satisfactory degree of air pollution control practiced on new equipment can be contrasted with the unsatisfactory degree of control generally employed on existing equipment. Many mills have, in addition to well controlled new equipment, old equipment with little if any air pollution control. Such

poorly equipped units include sintering plants, oxygen lanced open hearth furnaces, Bessemer furnaces and electric furnaces.

One of the knotty problems faced by the industry is that of cleaning up or preventing emissions from by-product coke ovens. These emissions, consisting of smoke, dust, sulfur gases, carbon monoxide and a host of organic compounds, are usually emitted when coal is charged to the oven and again when the coke is removed from the oven and quenched with water. Control of these copious omissions has not yet been accomplished to any significant degree. Further effort by the industry in this regard is needed. It may be that a radically new method of making coke will be required.

Some idea of the cost of controlling emissions from the steel industry can be obtained from the program underway in the Chicago Metropolitan Area. In March of 1965 the major steel manufacturers in the area entered into a 7-year agreement with the local regulatory agency to prevent emission of some 88,000 tons of dust annually. The total cost of the control program will be about $50,000,000. A similar program underway in Northwest Indiana will take 9 years to complete. When finished more than 186,000 tons per year or 29 percent of the potential emission is captured.

A third major industry, Mr. Chairman, the inorganic chemicals industry, includes those industries engaged in the manufacture of nitric acid, phosphoric acid, caustic, chlorine, and phosphate fertilizers. Pollutants include such well known compounds as sulfur dioxide, nitrogen dioxide, gaseous fluorides, acid mists and many other less common inorganic gases, mists and dusts. Control of emissions is normally effected by using wet collectors to remove pollutants from the discharged gases.

The technological ability to control pollution from this class of industry is fairly well advanced but some difficult problems remain. This is illustrated by the phosphate fertilizer industry and its captive sulfuric and nitric acid plants. Production of phosphates is increasing at a tremendous rate; an increase of 57 percent is predicted in the next 5 years. Wet scrubbers to remove fluorides can be designed for greater than 99 percent removal and dusts can be controlled to a similar or better degree using wet collectors or bag-houses. Acid mists can be removed using fiber mist eliminators at efficiencies up to 99.9 percent depending on particle size and energy expended. Sulfur oxides from sulfuric acid plants are difficult and costly to remove from effluent gases, and can best be curtailed by process control through a high rate of conversion of sulfur dioxide to sulfur trioxide and hence, sulfuric acid. New plants approach and equal this high degree of control in many cases. Older plants seldom do.

A particularly difficult problem in the fertilizer industry is the control of the continuous gaseous fluoride emission from fertilizer curing and storage structures. Scrubbers with gas flow rates up to 400,000 cubic feet per minute are required. Extensive piping is required to adapt these structures to control. Installations may cost $1 to $3 per cubic foot of gas exhausted. Since there is no return on the investment, industry has been slow to provide controls on these buildings. A better means of controlling emissions is badly needed.

Fluoride scrubbers are a continuous source of maintenance due to pluggage. Industry has overcome much of the corrosion problems but, with no monetary return on the control equipment, most companies are lax in maintenance of control equipment. Little research and development in control techniques is conducted by industry since no salable product is recovered.

The rapid growth of this industry will necessitate improvement in abatement efficiency just to maintain status quo on total emissions, particularly since the industry tends to cluster in a relatively small area near existing phosphate rock mining operations.

A fourth major industry, which I will classify as non-steel metallurgical, includes gray iron foundries, non-ferrous foundries, metal reclaiming operations and smelters of all types. The major pollutants are dusts, oil vapors, metallic fumes, sulfur dioxide and nitrogen oxides.

These industries contribute significantly to the general air pollution of many of the urban areas of the country. The metal casting industry, for example, ranks fifth among all manufacturing activities in the United States. Capital investment for new plant facilities exceed $12,000,000 per month. In 1960, there were over 6,000 foundries employing about 425,000 people. Control of pollutants from foundries is particularly difficult since the exhaust gases are normally at high temperatures and much of the particulate is of extremely small size.

Most of the conventional high efficiency air pollution control devices have been used more or less extensively on foundry emissions with some degree of success. Frequently, operating problems have been encountered. Electrostatic precipitators which have worked so well on other industries have not proved popular in the foundry industry. Precipitators operate most efficiently on steady state conditions of flow, temperature, and humidity. Cupola furnace operation is not conducive to steady gas flow conditions.

Bag filters have high efficiency but have temperature limitations and occasionally encounter high maintenance costs because of severe operating conditions. For these reasons wet collectors are used by many foundries. Because of the high percentage of submicron material, high energy scrubbers which are costly to operate are required to achieve high collection efficiency. A seldom thought of expense is that of disposing of the collected material, which in the case of foundries is a worthless item. Cost of controls is also a large factor. Many cupolas are small job-shops and operate only a few hours a day, 5 days a week. The high efficiency control required to remove the fine particulate may equal the capital investment for the cupola itself. For example a bag collector for a 6 ton per hour cupola may cost $50,000. Due to the high temperature encountered, maintenance cost on bag collectors is high, estimated by one operator to be $1,000 per month. As an alternate small job-shop cupolas frequently prefer wet collectors. A favorite is a "wet cap" which essentially forces the exhaust gas through a curtain of water. This type of collector may cost $12,000 for a small cupola. Unfortunately this type of control will not effectively remove the fine particulate in cupola exhaust gases and is not adequate to meet the air pollution controls necessary today.

There is an urgent need for control equipment at a cost the small foundry can afford to pay, which will operate at existing foundry process conditions and remove submicron material. Since equipment of this type is not available, many foundries have had to replace cupolas with electric induction or reverberatory furnaces. These furnaces do not require expensive air pollution control equipment.

Metal reclaiming and salvage is another troublesome metallurgical operation. Recycling these metal products back to useful products without creating a serious air pollution problem seems at times to be an unsurmountable task. A major area now being attacked is that of disposing of the mass of scrap automobile bodies. In the past, open burning was the most common method of removing paint, floor covering, undercoating and upholstery. This created great clouds of dense black smoke. Essentially smokeless incinerators have been developed to do this job but their cost is beyond the reach of most salvage yards. Mechanical separation of desired scrap iron and steel from unwanted materials is being practiced in a few areas, but mechanical separation equipment is also very expensive. Wire burning to salvage metal is another area creating pollution problems. Burning of the plastic coating now being used on wire results not only in ordors and particulate, but may result in the discharge of hydrogen chloride gas. Remote location is probably the most commonly practiced method of keeping the pollution from metal salvage operation out of urban areas. As our society grows this technique will be unsatisfactory and further control will be essential.

The fifth major industry of concern to us, Mr. Chairman, is the pulp and paper industry. Of the three major processes used in the pulp and paper industry, the sulfate or kraft process creates the most serious air pollution problems. While air pollution from this process is due to both particulate and odorous gas emissions, it is the odorous component of the pollution that is the most objectionable and difficult to abate. Particulates are emitted principally from lime kilns, recovery furnaces and, depending on the type of fuel used and firing practices, the plant boilers. Odorous gases such as hydrogen sulfide, mercaptans, and methyl sulfides, are generated mainly in the recovery furnaces, digesters, and evaporators.

The degree of control practiced from plant to plant varies widely. Control techniques are available to reduce particulate matter but methods of reducing odors need to be further developed.

Black liquor oxidation has been used since 1950 in western and northern mills to reduce odorous gaseous emissions. Methods were developed by the industry in 1962 to overcome foaming problems encountered in black liquor oxidation of southern pulp. Although black liquor oxidation reduces odorous emissions, its pollution control advantages may be overshadowed if the recovery furnace is

operated above its rated capacity, a widespread industry practice. Black liquor oxidation even if employed universally will not completely solve the industry's odor problem. To reduce or eliminate odorous emissions either a satisfactory method of scrubbing the vent gases from the recovery furnace and direct-contact evaporators must be developed or a process change must be introduced to prevent the formation of odorous compounds.

Particulate emissions from black liquor recovery furnaces are controlled by two methods—scrubbers, using black liquor, or electrostatic precipitation. Scrubbing, in practice, has been only 85 percent effective in particulate removal. Electrostatic precipitation used in the industry is usually 85 to 95 percent effective in particulate removal. Neither method will effectively reduce odors. Designs are available by both techniques to achieve particulate removal in excess of 99 percent efficiency, but at increased cost. For example, on a 550 ton per day mill a 90 percent efficient precipitator will cost about $230,000 or only about one-tenth of the installed cost of the recovery furnace. To control particulate at the 99 percent level, the precipitator might cost about $300,000 and its cost might increase to about $340,000 for 99.5 percent control.

The industry trend is toward larger and larger plants. While plants with a capacity of 200 tons per day were considered large in the past, new plants are being designed to produce 1,200 tons per day. The need for higher air pollution collection efficiencies is therefore apparent.

Generally speaking, new methods for controlling air pollutants have not been adopted at a rate comparable to that with which the industry has expanded. Even in the case of newly installed kraft mills which were said to incorporate all the latest means for air pollution control, there have been numerous public complaints about odors from the mills.

The sixth and last industry that I would like to discuss briefly, Mr. Chairman, is the organic chemicals industry. The various industrial groupings in this category include the manufacturers of synthetic rubber, rubber-processing compounds, synthetic fibers, elastomers, resins, and intermediate chemicals such as phenols and anhydrides. Pollutants from these industries consist generally of dusts, mists and a variety of odorous organic vapors associated with the materials of the process. Control of these pollutants is effected by the use of gas scrubbers, adsorption on activated carbon, catalytic oxidation or incineration. An exception is the carbon black industry. Here the pollutants are fine particles and the principal means of collection are cyclones followed by fabric filters and electrostatic precipitators.

Our technology for controlling organic emissions is not as well developed as emission control in other areas. Water scrubbing frequently does not reduce odors to acceptable levels. Some success has been achieved by using a scrubbing solution that reacts with the organics to form odorless products. Catalytic oxidation may fail because of poisoning of the catalyst by components of the gas stream. Direct flame afterburners have, in many cases, been the only method which successfully destroy organic vapors. These afterburners are not only costly to operate because of high fuel use rates but also add to emissions of nitrogen oxides.

Odors are hard to destroy because certain chemicals have extremely low threshold levels of odor detection. Improved plant maintenance and process changes are effective in reducing some odor problems.

A typical industrial problem is the manufacture of paint and varnish. The primary pollutants are aldehydes and organic sulfur compounds which are given off during the cooking process. The most commonly used control method, although not the most effective, is scrubbing with a liquid such as water, oil, or alkaline or acid solution. The most effective methods are the use of direct flame and catalytic afterburners to completely oxidize the effluent vapors. Removal efficiencies of 85 to 98 percent are reported for scrubbing and 100 percent for incineration.

The cost of emission control equipment for the organic chemical industry is not as great as that for some other industries. Scrubbing equipment, which is the most common means of control, costs one-tenth as much as high efficiency collectors such as electrostatic precipitators and fabric filters as are required by the metals and minerals industry. The organic chemical industry has had an average production growth rate of 10 percent per year for the last 4 years and sales of $8 billion for 1964. This represents about one-fourth of the total chemical and allied products industry. The chemical industry capital spending was esti-

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 enivornmental 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

occupational and general importance. The further pursuit of studies of this type may result in the evolution of general concepts applicable to the identification of susceptible individuals and protection of such individuals. The immuno-chemistry of gaseous agents should also be more extensively studied.

Our present ability to detect changes in man may not be adequately sensitive. Either the methodology is too insensitive, the experimental design is not good, or the wrong responses are being investigated. New responses, and/or more sensitive detection methodology, appear to be promising avenues. Improved methods of odor detection and discrimination, of measuring eye irritation response, visual acuity definition, and central nervous system response hopefully will provide new estimates of threshold values for human criteria.

An increasingly important need in the realm of health effects is more adequate evaluation of the contribution of air pollution to accidents. For example, reduced visibility, eye irritation, increased carboxyhemoglobin (with attendant impairment of operating performance), and contribution to stress status, are readily itemized as potential dangers to air and ground traffic.

More thorough evaluation of the potential effects of pollutants upon the eye and upper respiratory tract, both alone and in the presence of infectious agents, is desirable. Considerable losses in manpower due to absenteeism have been correlated to air pollution exposures, but the specific contribution of air pollution has not been clarified.

As this partial list of some of our needs for research into the health effects of air pollution indicates, Mr. Chairman, our knowledge is far from perfect. And since our knowledge is imperfect, there has been some reluctance on the part of the scientific community to develop air quality standards. It seems to me, Mr. Chairman, that we should get on with the job. Our knowledge of the effects of air pollution will in all likelihood never be perfect, and for that matter air quality standards will in all likelihood never be established purely on the basis of scientific knowledge. The health threshold for human exposure to radioactive substances is zero. Yet few of us would take the purist view that the use of X-rays for medical purposes should be banned and that atomic energy plants should not be built. To eliminate traffic fatalities completely we would need to eliminate motor vehicles completely. Yet few of us would see the automobile destroyed. If we are to apply the rational approach to air pollution control, we must achieve a consensus on what "clean air" should be, and we will achieve that consensus only by considering the relevant factors of environment—social, political, and economic, as well as scientific.

As you know, Mr. Chairman, in the Clean Air Act the Congress recognized the need for yardsticks of air quality, calling upon the Secretary to publish criteria reflecting the latest scientific knowledge of the predictable effects of various pollutants in the atmosphere. This Department has prepared in preliminary form criteria for two principal classes of pollutants, the sulfur oxides and the photochemical oxidants, and is working on criteria for two other classes, the nitrogen oxides and carbon monoxide. It is hoped that these criteria will assist the States and local governments in establishing air quality standards.

The second problem we must solve if we are to apply the rational approach to air pollution control is technical. We do not have today fully developed methods of bridging the gap between air quality standards and source emission standards. Our methods are particularly deficient for that very situation in which air pollution is most critical—the multiple source of urban situation. For suspended particulate matter we can approxmimate the transition using emission inventory techniques. The particulate matter omitted from each source in an area can be estimated, and from a comparison between the overall estimate and the air quality standard a percentage reduction can be calculated. For some gases and fine particles computer programs have been written to accommodate a large number of sources of different cetagories, to take into account varying times of maximum emissions, and to take into account varying meteorological conditions. However, these programs require a wealth of date, and they have not been developed to the point where they will accommodate reactions between pollutants after they leave the source, such as the reactions which result in photochemical smog, and they will not accommodate particulate matter that falls out, or nuisances, such as odors, which usually emanate from a single source.

Mr. Chairman, this concludes my review of the adequacy of the present technology for controlling air pollution. I would like finally to briefly describe for you some of the forms and the extent of Federal Government efforts to advance that technology.

FEDERAL RESEARCH AND DEVELOPMENT ACTIVITIES

The functions of conducting and supporting research have been an integral part of our Department's air pollution activities ever since the establishment of the Federal air pollution program in 1955. In Fiscal Year 1966, which ended on June 30, about $14 million was invested in research activities. This sum represented some 55 percent of the funds appropriated for the air pollution program. For the current Fiscal Year, our budget requests includes about $18 million for research activities.

Of the total for Fiscal 1966, about 30 percent was allocated for research in our own facilities, mostly at the Robert A. Taft Sanitary Engineering Center in Cincinnati. About 10 percent was used to support research by other Federal agencies—the Environmental Sciences Services Administration and the National Bureau of Standards of the Department of Commerce, the Bureau of Mines of the Department of the Interior, and the Tennessee Valley Authority. Contracts with non-Federal institutions and agencies, including industrial firms, accounted for 20 percent. The largest single portion, about 40 percent, was awarded to non-profit institutions, mostly universities, to support needed research projects.

This research effort includes a broad range of investigations of the nature, extent, sources, effects, and control of air pollution, and the scientific disciplines involved include many branches of the physical and biological sciences. Among the more important elements of the program are laboratory studies of the adverse effects of air pollutants on animals and clinical studies of effects on man, epidemiological and statistical studies of the occurrence of illness and death in relation to various measurements of air pollutions, field investigations of the effects of pollutants on materials and structures, engineering investigations of the nature and control of pollution from such major sources as motor vehicles, fuel combustion, and manufacturing activities, and studies in the social sciences. I want to discuss some of these research areas briefly.

In the areas of medicine and biology, studies are being conducted to determine the biological responses of laboratory animals living in ambient air in urban areas over a long portion of their life span as compared with those living in cleaned air. In related laboratory studies, animals are being exposed to synthetically derived polluted atmospheres, e.g., irradiated and non-irradiated auto exhaust, mixtures of auto exhaust with added sulfur dioxide and nitrogen dioxide, and various pure gases and particulates, singly and in combinations. Preliminary experiments suggest a lowering of fertility and infant survival of animals exposed to irradiated exhaust. Biochemical changes in the lungs and activation of spontaneous disease appear to result also from chronic exposure to irradiated exhaust.

Other studies involve effects of potentialily cancer-producing materials derived from combustion and industrial sources and found in polluted air; the potentiation of infectious disease (e.g., bacterial pneumonia) by exposure to air pollutants such as nitrogen dioxide or ozone; changes in electroencephelogram patterns in rats on exposure to air pollutants such as carbon monoxide and ozone; clinical studies to define more specifically the components in photochemical smog that produce eye irritation and define the increased oxygen requirements of patients with pulmonary disease exposed to ambient or filtered air; and phytotoxic effects of pollutants such as auto exhaust, ozone, nitrogen oxides, and sulfur dioxide with a number of plant species and exposure conditions.

Epidemiological studies are focused on the effects of air pollution on health, with emphasis on respiratory diseases. In field studies, some of the health effects that might be attributable to air pollution (and other environmental factors) are measured, as are the levels of air contaminants. In Nashville, effects on patients with asthma were correlated with atmospheric pollutants. These correlations indicated that the asthma attack rate varied significantly on days of high and low concentrations of sulfur dioxide. In Seward and New Florence, Pennsylvania, statistically significant differences in average airway resistance were found in residents of the two communities which differ greatly in ambient air pollutant levels sulfur dioxide, dustfall, and soiling. In New Orleans, the incidence of asthma outbreaks has been studied in relation to wind speed and direction, types of pollutants in the atmosphere, allergic reactions, and possible sources of pollutants. Results thus far show that samples taken

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

them to the local situations, and to apply computer techniques to the forecasing operation.

Mathematical models are being developed and tested to describe the individual and cumulative effects of pollutant sources on air quality in an urban area. These models range in complexity from simple graphical presentations to highly complex descriptions of sources and of air flow patterns. Tracer studies are being undertaken to investigate the variability of dispersion parameters as they pertain to the roughness elements in the urban situation.

To provide continuing information on major trends in air pollution, we operate three air monitoring networks. One system of stations, the National Air Sampling Network (NASN), includes some 250 stations, which sample for suspended particulate matter; 50 of these stations also sample for sulfur dioxide and nitrogen dioxide. The stations obtain 24-hour integrated samples on a random schedule about once each two weeks. Stations of a Continuous Air Monitoring Program (CAMP) are operated in Cincinnati, Chicago, Philadelphia, Denver, St. Louis, and Washington, D.C. At each CAMP station, a set of instruments automatically measures and continuously records the atmospheric levels of carbon monoxide, total hydrocarbons, nitric oxide, nitrogen dioxide, sulfur dioxide, and total oxidants. A surveillance network has recently been set up to assist in the evaluation of effects of pollution in urban areas extending across State boundaries. These stations in this Surveillance Network for Interstate Pollution Effects utilize an "effects package" to measure dustfall, particulate impingement, sulfation, corrosion, tarnishing of metals, and deterioration of textiles, dyes, and rubber. Plans are to establish about 60 stations of this type this year.

Other Federal agencies play an important role in our research efforts. The Weather Bureau of the Environmental Sciences Services Administration of the Department of Commerce has carried the major burden of meteorological studies. The Bureau of Mines of the Department of the Interior is engaged in numerous projects relating to the nature and control of pollution from fuel combustion, primarily sulfur oxide pollution from the combustion of fossil fuels. The Tennessee Valley Authority is active in meteorological and engineering studies relating to pollution from large fuel-burning installations; the Agricultural Research Service and the Forest Service of the Department of Agriculture in studies of air pollution effects on plant life and the Bureau of Standards of the Department of Commerce in studies of the basic chemistry and physics of air pollution. The Library of Congress has been our principal bibliographical resource.

Although not, in contrast to the above noted agencies, recipients of all pollution research funds by transfer from this Department, the Office of Coal Research of the Department of the Interior, the National Science Foundation, the National Space and Aeronautics Agency, the Atomic Energy Commission and the Department of Defense have all sponsored research of great value to a better understanding of air pollution, its effects and its control.

I have given a rough indication, Mr. Chairman, of the extent of the air pollution research and development activities that are presently being carried out in the United States. I will be pleased to submit for the record a detailed breakdown of our Department's activities in this area. Further, under an arrangement with the Americal Society of Mechanical Engineers we are currently gathering detailed information on the air pollution research and development activities being carried out under other than Federal auspices. This information should be complete sometime in the fall of this year, and I will also be pleased to make it available to the Committee.

To conclude my remarks, Mr. Chairman, we have studied the report of the Research Management Advisory Panel to your Committee, and we are in agreement in large part with the fundamental findings of the report. As the report indicates, the quality of life is to a large extent dependent upon the quality of the environment. But it is only in recent years that we have begun to understand this relationship, and particularly to understand how dependent we are on our fundamental resources of air, water, and land. For the greater part of our historical development our interest in the environment was primarily that of subduing nature so that she would serve man better. We had to convert many of our beautiful rivers and lakes into practically open sewers before we concluded that we must conserve our water resources, and we had to experience the tragedy of Donora and the anguish of Los Angeles before we began to realize

that the seemingly infinite ocean of air that surrounds this planet has decidedly finite capacities for diluting and dispersing the wastes we throw up from our civilization. In our singleminded devotion to achieving the benefits of science and technology, we plunged ahead with the abundant materials at hand, without a very precise notion of where we were going and without serious attention to the possible side effects of our activities on the environment.

Today it is important that we can no longer with impunity discharge wastes indiscriminately to the environment. It is apparent today that we must use our science and technology to control the by-product problems of our industrialized society as well as to produce the goods and services we all increasingly enjoy. And it is apparent that we are going to have to run very hard in the immediate years ahead just to keep pace with the problem. We must greatly expand our application of technology to the sources of pollution, and we must accelerate our efforts to further develop that technology. I am convinced, Mr. Chairman, that the attention focused on these needs by this Committee will make a substantial contribution to our progress toward the control of environmental pollution.

We don't have much time and I regret, Mr. Gilbertson, that we did not get to you sooner. We still have 10 to 15 minutes. Please go into your report.

Mr. GILBERTSON. Yes, sir, Mr. Chairman, I'll be very glad to.

STATEMENT BY WESLEY E. GILBERTSON, CHIEF, OFFICE OF SOLID WASTES, PUBLIC HEALTH SERVICE, U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Mr. GILBERTSON. In the interest of time, I will submit my statement for the record and then touch on a few highlights of it. This is a sort of status report on the adequacy of technology for solid waste pollution abatement. I think that I could say without fear of overstatement that few problems of the environment need more work in the field of technology than does the solid waste area. It is, however, encouraging that the Federal Government has underway a national program to advance the technology of solid waste management under the Solid Waste Disposal Act which was adopted by the Congress last October.

The thrust of this legislation is basically a research, technical development, demonstration, and planning authorization for purposes of preventing and solving solid waste problems which contribute to health hazards, scenic blight, and environmental decay, through the application of technology—which I will touch on—with reference to garbage, to trash, junk, and other solid wastes from municipalities, from industry, and from agriculture.

It would be safe to say that the solid waste problem has reached major proportions during many years of public indifference and professional neglect. This is true even though large sums of money are spent by public agencies and by private citizens and industries on disposal costs. They are paying for this, we are all paying for it, without really getting done the job that we would like to have done. The history of the solid waste problem, which might be called the third side of the pollution problem, is somewhat in contrast, I think, with what has happened in the other areas of environmental contamination and pollution almost down then to the present time. As a matter of fact, up until about a year ago the total Federal expenditures in this field were about $250,000 a year for R. & D. So as a

result of this lack of attention, the solid waste technological void is certainly a great one and results in the fact that we must now be prepared for a long-term effort to take care of it.

Our national program under the solid Waste Disposal Act calls for scientific research, training, field investigations, and demonstrations. We look at this problem not solely in terms of what the Federal Government will do but also in terms of what local, State, and private agencies will undertake in coordinated fashion. Thus, a nationwide program is envisioned. I will only touch briefly on the health hazards involved. Certainly, it is well known that inadequate solid waste practices and facilities are breeding places for insects and rodents which carry disease. Solid waste disposal frequently involves contributions or generation of air and water pollution; inadequate handling of solid waste also involves accident hazards and certainly also causes fire hazards.

In this particular area, I think I should stress very strongly the area of interrelationship, the question of interrelationships which has already been touched on by two or three members of the committee. In no place perhaps do we come into a pollution area where the impact of one form of pollution on the others is so evident and so much a part of the daily considerations of the R. & D. effort which it is called on to solve it.

The interrelationship therefore, really is part of the basic facts that we must consider at every step we take.

I should just like to leave the question of the size of the problem with a very brief reference to the fact that it is growing. The amount of solid waste generated per capita per day in the United States has risen from somewhere between 2 or 3 pounds to around four and a half pounds within a very short time. It is higher in some locations, 6 or 7 pounds in some cities, and on a national average we project a national average of between 5½ and 6 pounds per capita per day by 1980.

This means then that we are dealing somewhere in the neighborhood of 800 million to a billion pounds of material a day that has to be handled in an adequate and safe way. And as has been brought out very effectively, I think, in the hearing this morning, as we move up our standards and therefore our controls in the field of air pollution and in the field of water pollution—this, then, automatically increases the solid waste problem. So the past quantities I think are far underestimated and so, in all probability, are projections for the future. I should also like to say that we see qualitative changes as well as quantitative ones. I say this from several standpoints. First, our society's use of materials is changing. Our rising output and use of pesticides, solvents, household chemicals, and industrial chemical materials results in wastes that are known to be hazardous. And then the removal of contaminants from air and water also results in qualitative changes as well as the quantitative ones. Thus, a greater amount of toxic chemicals, even cancer-producing ones, are being thrown into the "solid waste stream," if we can call it that. All of these things focus the public demand for a higher quality environment, and this then, coupled with the enactment of the Solid Waste Disposal Act, does provide an opportunity and a challenge to move ahead

with a program. I think this is a very mature piece of legislation, because it does specifically spell out the requirement that all of the pollution aspects must be taken into consideration when we look at the solid waste problem. In other words, in looking at the planning questions, in looking at the research and development questions, the legislation spells out the interrelationship that must be taken into consideration.

Furthermore, we and the States and localities and industries involved, are expected to also take into consideration all the planning and development questions involved, and these, I think, are very important ones that need to be taken into consideration.

Another factor in what I have termed the maturity of approach, is that the act makes it clear that we are talking about solving the solid waste problem in terms not only of just simple disposal questions per se, even though that may be safely done. Here we are looking at ways in which we can reduce the generation of wastes at their sources, to possibly recycle them back into production, to increase the salvage of useful items, and to convert these wastes then into beneficial uses for mankind.

Then finally another aspect of the mature approach is one which has been touched on; namely, the need for somewhat larger scaled operations in order to do a decent job. The tendencies toward fragmentation of this problem among very small geographic or political units has been a deterrent, we believe, in the application of the technology that is now available. A very important part of the Federal program involves efforts to encourage a larger scale approach, a regional approach in some instances. In metropolitan areas which regionally approach the situation, a better planning job can be done, and improved technical resources can be brought to bear, because they are dealing with a larger operation. They can scale up the facilities and, therefore, obtain better economies, cost benefits, and so forth. These indicate some of the important points of maturity in the legislation itself.

The Office of Solid Wastes was established in the Public Health Service only about 8 months ago, and since that time as you can appreciate we have been busy, engaged in establishing the fundamental program and the major areas of activity. I think I can report that we have successfully launched activities in the five major areas that were projected by the Congress in the act.

We have initiated a research program through the grants and contracts mechanism, and we are tooling up our in-house research. We have initiated a program for demonstration of new and improved solid waste systems.

Here we are talking primarily about shortening the time gap between laboratory bench-scale types of ideas and their application on a community level. And this certainly is an important consideration when we try to work out the change or upgrading of technology in any field. Mention has been made earlier of the need for better professional trained manpower, and we have initiated four training programs at universities. We went to the limit of the funds this last year, and we have additional good applications which will be funded during the coming year.

In addition, we have initiated, admittedly so far on a small scale, the direct training activities of the type that was referred to earlier in the air pollution field. The question of professional development we think is very critical. As a matter of fact, I think it is fair to say that here we are faced with a particular problem because some people perhaps think it beneath their dignity to look at the solid waste problem. We have to get an attitude changed here. It needs technological input to it. There are tremendous costs to society, both health and aesthetic. Even before we had the advantages of the new act we had begun on a very small scale to bring together the researchers in this field, to identify them, and to start working with them. We had a National Conference on Solid Waste Research. We have done a number of things through the technical and professional organizations to give solid waste research status, you might say, so that people would begin to give it the attention that it deserves. We are very gratified that this change in point of view is taking place. Certainly the new act has been a major factor in this change.

In terms of State activities it is safe to say that with perhaps a handful of exceptions that is very little going on at the State level in this field. There are a few States which have begun programs within the last year or two. Some States have enacted legislation and this, of course, is a base for State activities. We awarded during the past fiscal year grants for statewide solid waste program activities in 14 States. This is for development of comprehensive solid waste plans for the immediate and long-range management problem of the State, including the factors I mentioned earlier such as relationship to water and air pollution, economic development, land use planning, and particularly the advantages of regional solid waste management efforts. And then finally we have begun a program of technical services to provide the types of assistance to State, local, and industry groups mentioned previously.

Now, I think that it is pretty obvious that in a field like this where so little has been done and so much needs to be done, it is very necessary to very carefully select the kinds of activities which should be carried out. Mention has been made earlier in the hearing of the need for standards, criteria, and guidelines, and I'm glad to report to the committee that this is one of our major priority areas. That is, using technical information as it becomes available, building on what we have, which is little enough, but adding to it, to develop the kinds of standards that can be applied not only by State and local governments but also by industry in its development activities for its pollution problems and for abatement facilities and devices. In other words, if they have something to design to or to work toward, this then gives them a better chance for their own R. & D. effort.

In particular I think it is fair to say that one of the key underlying philosophies which we believe the Congress intended and which we are trying to implement, is the injection of a spirit of innovation in this field. I think it is pretty obvious that in no area are there greater opportunities for innovations and new ideas. For this reason the opportunities for working with industry and with research groups is a wide one, and we believe that the basic methods of the research grant and the contract mechanism should be utilized to the fullest extent in the months to come.

One of the big problems here has been that we really have not had a total national summary of where we are in this field. This is necessary, obviously for many purposes, basically for program planning and development. We believe that our working with the States over the long pull will be a very important factor in terms of getting together some ideas about the extent of the problem, the trends and quality, of practices, and so forth. But this again will be spotty as long as many States have not been active in this field and they will take time to gear up. We have initiated, through a contract, a technical-economic survey of practices and needs covering about 450 cities and 90 industries. We believe that this will be a satisfactorily large sample to give us an idea of where we are in this national picture.

In the more technical field we have initiated a study through a contract for a series of state-of-the-art reports on various kinds of unit processes that could be applied in the solid waste field. Many of these will come directly out of industrial processes and have previously never been applied to this field at all. We think this will be an important mechanism for transfer of technology from other fields into this field.

Mr. Chairman. I would like to wind up rapidly here by commenting on a couple of points which are extremely important but will be very difficult, I am sure, to get hold of. The first of these is: how do we reduce the burden by cutting down on waste generation at the source? Now here we are getting into some questions that have long-range implications, because we are talking about the question of whether products can be designed so as to reduce the ultimate waste problem connected with them, or whether the products of manufacture can be designed in such a way that they are more easily handled from the waste disposal point of view. I might inject a note of humor here, sir. Somebody came up with a question to me the other day. Do you mean that you are now going to make beer cans out of pretzels? This might be an outlandish idea but it has a point here. We are talking about whether products themselves can be thought of in terms of their disposal, as well as in terms of the utility involved.

Mr. DADDARIO. I got a sample of paper through the mail a day or two ago which dissolves when you place it in water.

Mr. GILBERTSON. This is a very good example. I agree with you.

Mr. BROWN. If I might cite another example, it seems to me the principle is the same as buying ice cream in a cone.

Mr. GILBERTSON. Yes, sir; that is excellent. So, the whole idea of reducing waste at the source deserves a great deal of attention. Important also is the question of recovering and reusing wastes. There are some difficult questions here. There are certainly broad economic questions that are involved, and I doubt very much whether substantial technical progress can be made in this area without a great deal of backing from the public and by the Government, in addition to whatever economic forces that might be called to play here. The whole question then of recovery, reuse and salvage of valuable materials offers some promise as far as routes to modernization of the pollution problem.

I might mention that one way of recovering certain values from wastes could be more widely used, and that is the use of wastes for

land reclamation, where this can be done on a planned basis, perhaps with the use of new technology such as greater density and compaction, so that otherwise useless lands could be put into very productive uses.

So far I have talked almost entirely about the question of treatment, processing and disposal. I would like to note that we are thinking now more about a series of processes, a treatment approach here rather than just a single action of disposal. I think this point is very important. But I haven't mentioned the question of collection of waste, and here we are talking about an area which economically and from the standpoint of health and aesthetic questions is an important one. As a matter of fact, from the cost point of view some 60, 70, or 80 percent of the total cost of solid waste disposal is involved in the collection question, and here research, development and innovation hold a great deal of promise and certainly need to be worked on. I think that here we probably most effectively can carry out our activities in perhaps what you might call new communities or new towns. Perhaps these facilities will require the same kind of thinking, the same kind of early planning and development as we now have involved in the basic public utilities. So, our work here, will be directed primarily at innovations that can be incorporated in the completely new cities. And in connection with this, the use of systems management, beginning with the interrelationships among the waste systems supports the fact that, if you move to a somewhat larger scale of operations geographically, new potentials come into view. We recently have asked the newly established National Academy of Engineering to work with us in looking at some of the practical ways in which steps could be taken to apply some of the concepts that we have been working with.

The National Academy of Engineering has agreed to do this. We also have held two or three national meetings, including a national conference on systems analysis and waste management earlier this year, and this I think developed further interest in the field.

The Federal role in generating activities in the private sector is worthy of brief comment. It seems to me that there are opportunities here for us to work with industry. There are several ways that industry can and undoubtedly will participate in the program. The information derived from the national R. & D. program will help industry to meet its own solid waste problems. Then, of course, we feel that industry will be looking toward the possibility of a significant expansion in the solid waste management industry itself. We have some specific examples of that already.

We have developed certain Federal interagency relationships with reference to the solid waste planning question. We have developed a working understanding with the Department of Housing and Urban Development whereby the State solid waste planning activities and the so-called 701 planning activities of HUD will be coordinated through the State agencies concerned, and we have a working memorandum of agreement with the Bureau of Mines of the Department of the Interior regarding the mutual and respective responsibilities under the Solid Waste Disposal Act, and we will be glad to furnish that to the committee if it is desired.

Mr. DADDARIO. If you would, please.
Mr. GILBERTSON. Yes, sir; we will do that.
(The memorandum requested follows:)

MEMORANDUM OF UNDERSTANDING RELATIVE TO IMPLEMENTATION OF TITLE II, THE SOLID WASTE DISPOSAL ACT OF 1965 PUBLIC LAW 89-272

The Department of Health, Education, and Welfare, Public Health Service, and the Department of the Interior, Bureau of Mines, each has an area of responsibility for implementing the provisions of Public Law 89-272, the Solid Waste Disposal Act, and are mutually desirous of developing a coordinated program toward the attainment of common objectives under the Act. The report of the House Committee on Interstate and Foreign Commerce (Report No. 899, page 27, lines 19 through 36), states that, under the provisions of the bill, subsequently enacted as Public Law 89-272, the Department of Health, Education, and Welfare "would be responsible for administration of the Act, except that the Secretary of the Interior will be responsible for 'solid waste resulting from the extraction, processing or utilization of minerals and fossil fuels where the generation, production, or reuse of such wastes is or may be controlled within the extraction, processing or utilization facility or facilities and where such control is a feature of the technology or economy of the operation of such facility or facilities'. This arrangement would make the Secretary of Health, Education, and Welfare responsible for administration of the Act with respect to solid waste problems of communities, including those problems which may affect the general environments of communities, and including those solid wastes or solid waste residues that result from business and industrial activities and become part of the community's solid waste disposal system. The Department of the Interior, as above indicated, would be responsible for solving industrial solid waste problems within facilities engaged in extraction processing, or utilization of minerals and fossil fuels in the circumstances above defined." To accomplish these objectives, the Public Health Service and the Bureau of Mines have entered into this Memorandum of Understanding in order to define and describe the principal areas of program interest of each agency and to clearly establish a mutually acceptable working relationship which insures proper coordination of all programs under Public Law 89-272.

It is mutually agreed that:

A. The Public Health Service and the Bureau of Mines will designate officials to act as the principal contacts and liaison officers at the program level in interagency matters pertaining to Public Law 89-272.

B. In regard to demonstration grant applications under Section 204 of Public Law 89-272, the Public Health Service will refer to the Bureau of Mines for necessary action, those demonstration grant applications pertaining primarily to mineral or fossil fuel solid waste problems as defined under Section 203(1) of the Act; and the Bureau of Mines will refer to the Public Health Service for necessary action those demonstration grant applications pertaining to other solid waste problems.

C. The Public Health Service will refer to the Bureau of Mines for review and comment those demonstration grant applications which give major emphasis to components involving mineral, metal, and fossil fuel solid waste problems as part of a broader solid waste disposal program; and the Bureau of Mines will refer to the Public Health Service for review and comment those demonstration grant applications in which the mineral and fossil fuel solid waste problems have significant community implications. In the above cases, it is understood that any comments the reviewing agency wishes to make will be forwarded within a period of fifteen (15) working days from the time of receipt.

D. The Bureau of Mines and the Public Health Service may support, on a joint basis, demonstration, research, or training projects which have implications for disposal of solid wastes from minerals or fossil fuels and from community sources.

E. The Public Health Service and the Bureau of Mines will perform reimbursable services for each other, when such action is appropriate and feasible and mutually beneficial to the agencies.

F. The Public Health Service and the Bureau of Mines will exchange information regarding program activities under Public Law 89-272. This will include information on grant awards and similar actions.

G. The Public Health Service in carrying out its responsibilities for developing comprehensive State and local solid waste programs, and in providing technical assistance to State and local agencies and industry, will need technical information from the Bureau of Mines. From time to time such information will be made available by the Bureau of Mines to the Public Health Service.

H. Since the processing and disposal of automobile and other metallic scrap involve problems of community environmental pollution, blight, and parallel resource problems in the technology of salvage and utilization, the Public Health Service and the Bureau of Mines may jointly conduct projects on broad phases of the junk and scrap auto problem, and individually on specific appropriate complementary segments.

This Memorandum of Understanding shall become effective upon acceptance of both parties, and shall continue indefinitely, but may be modified at the request of either of the cooperative agencies. This agreement may be terminated by either agency upon thirty (30) days notice in writing.

June 7, 1966. DEPARTMENT OF THE INTERIOR,
BUREAU OF MINES,
WALTER R. HIBBARD, Jr., *Director.*

June 3, 1966. DEPARTMENT OF HEALTH, EDUCATION,
AND WELFARE, PUBLIC HEALTH SERVICE,
WILLIAM H. STEWART, *Surgeon General.*

Before closing, then, I think I would only like to summarize what we think the Federal Government can do under this new program. It can provide leadership and stimulation for innovation in solid waste management. It can supply some resources not elsewhere available for research development and demonstration of improved technology. It can help in disseminating information on new types and prototypes of solid waste programs which meet the requirements for the protection of health, prevention of water and air pollution, and improvement of the general environment.

However, it is important to mention also that the national program can do no more than demonstrate the ways in which these new approaches, the new technology can replace outmoded and inadequate systems and practices.

The final steps, of course, have to be taken by people in industry, in the communities and the States throughout the Nation, and we hope that we can help make that come about.

This will conclude my summary of the statement.

Mr. DADDARIO. We have come to the quorum call. I'm sorry we don't have an opportunity to ask you any questions, but we will submit some for the record as we have discussed earlier. I would like to announce that on Tuesday next we have two important witnesses who will come before this committee: Dr. Tukey, who is the Chairman of the President's Science Advisory Committee on this subject; and Dr. Spilhaus who chaired the report on pollution for the National Academy of Science. We are pleased that they will be appearing here on the same day because we think they can make significant contributions to these hearings.

You have already done that. I'm extremely pleased with your participation. It has been helpful to us. We would like to supplement the record through questions which we will ask to make the record clearer.

Mr. GILBERTSON. We will be very happy to do that and I take it that some of the questions that were asked earlier about budget and training and research and so forth in the air pollution field would probably apply equally in this area and if you wish we can furnish those figures.

(Additional questions and answers for the record may be found in vol. II.)

Mr. DADDARIO. Yes. We will have our staff get together with you so that we can fill in all of those gaps. I want to thank you all and wish you would thank Dr. Cohen for having come this morning. This committee will adjourn until Tuesday next, same place, at 10 a.m.

(The prepared statement of Wesley E. Gilbertson follows:)

PREPARED STATEMENT BY WESLEY E. GILBERTSON, CHIEF, OFFICE OF SOLID WASTES, PUBLIC HEALTH SERVICE, U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Mr. Chairman, I welcome the opportunity to present here a status report on the adequacy of technology for solid waste pollution abatement.

Few problems of environmental health technology more greatly need the interest and concern of the Subcommittee and, indeed, of the entire Nation.

The Federal Government now has under way a national program to advance the technology of solid waste management under the Solid Waste Disposal Act. This legislation was adopted by the Congress last October to provide the Nation with the means of preventing a crisis in solid wastes in terms of health hazards, scenic disfigurement, and the physical enormity of the job of safely disposing of vast daily accumulations of garbage, trash, junk, and other solid wastes from municipalities, industry, and agriculture.

The solid wastes problem reached major proportions during many years of public indifference. Most people had virtually no interest in solid wastes unless their refuse was not regularly collected, or they happened to live near an open dump with its hordes of disease-carrying insects and rodents, or an overloaded incinerator with its noxious stenches and smoke clouds. Most people forgot about solid wastes the moment they were out of sight. Although huge amounts of public funds were spent for waste collection and disposal, little public or private money was invested in those years of indifference in solid waste research or even in such improved disposal equipment as was available.

So the history of solid wastes, in sharp contrast with what occurred in other areas of environmental contamination, is a history of technological neglect down almost to the present time. Until the Federal Government committed itself to a national program, the annual expenditure for solid wastes research was about $250,000 as against multi-million-dollar outlays for research and development relating to air and water pollution abatement.

Because of the lack of research and development, solid waste disposal methods common throughout the United States today represent little advancement beyond the technology of the garbage pail, the trash can, the open dump, and the obsolete incinerator. The technological void which the national program was devised to fill is truly great. We must be prepared for a long-term effort to fill it.

A problem which has been building up for decades cannot be solved easily or quickly, and its solution will depend on continuing public support for an effort requiring substantial funds over a long period of time. The national program calls for an assignment of public resources for scientific training and research and field-scale investigations and demonstrations in solid waste management. This resources assignment, moreover, is to be made not by the Federal Government alone, but by local, State, and private agencies as well. This means that support for the program not only must be sustained, it must be nationwide.

Fortunately, the American people today are concerned as never before about the quality of their environment. I think we can count, therefore, on their support for a program which, in time, can fill our backlog of needs in solid wastes. Surely we can count on their support as people become more universally aware of the degree to which our 19th century solid waste disposal practices not only deprive them of aesthetic values in their environment, but threaten their health as well.

In evaluating health hazards, it sometimes is necessary, and often wise, to follow the dictates of common sense or what the medical scientist might call diagnostic intuition.

The environmental threats to health are most difficult to establish and frequently, when they are established, turn out to be the ones we had suspected all along.

But I submit that we no not need to wait for scientific proof of disease relationships to sustain conviction about the seriousness of health hazards associated with the disposal of solid wastes. It is sufficient to know that more than 20 human diseases are carried by rats and insects proliferating in tens of thousands of open dumps. It is also sufficient to know that solid waste contamination of the land usually results in health-threatening air and water contamination. Gross pollution of water is produced by open dumps or improperly designed and operated landfills. Open burning or inefficient incineration of solid wastes are major causes of air pollution in many cities.

Since we are now committed in this country to control water and air pollution, it seems appropriate to make very clear the fact that, fundamentally, there is only one pollution—pollution of the earth. Air, water, and land are reservoirs, vast but not limitless, in which wastes may be stored. The reservoirs are interconnected and interrelated. To pollute one may be to pollute all three. And this is precisely what we will continue to do unless we develop and apply technology far more sophisticated in solid wastes pollution abatement than anything we have used up to now.

Technologically, solid waste management lags far behind air and water pollution control. Furthermore, the physical burden of solid wastes is increasing annually more rapidly than the population, and we are generating more of the kinds of materials which are particularly difficult to return safely to the air, water, and land.

But referring for just a moment to the future physical solid waste burden, I think estimates with which I am sure Subcommittee members are familiar, are too low. They show the present rate of daily solid waste collection going from 4.5 pounds per person to around 5.6 pounds by 1980 to push the total yearly accumulation from 165 to 260 million tons during the same period.

But it must be borne in mind that these are collection figures. We do not have, we badly need, and we are in the process of obtaining data which will give us an accurate picture of the amounts of waste being generated in this country, including those privately collected and disposed of, by municipalities, industry, and agriculture.

I feel certain that collection figures do allow sufficiently for additions to be made to solid wastes as more and more pollutants are extracted from air and water. Municipalities and power, petroleum, chemical, and many other industries will add vast quantities of a large variety of waste materials. In sulphur and fly ash from fuel combustion alone the increase will be in the millions of tons yearly.

Without underestimating the size of the task of managing great new amounts of solid wastes which our technological and population growth will generate, it should be appreciated that the solid waste burden will change qualitatively as well as quantitatively. For example, progressive effectiveness in removing harmful pollutants from waste streams leading to the air or to the water must and does involve diverting these pollutants to the solid waste stream. Many of these materials are nearly nondegradable, complex chemical compounds with varying degrees of toxicity for man, domestic animals, or wildlife. A few are known cancer producers. Quite clearly, important future research under the national program must be aimed at meeting this new health challenge.

Mr. Chairman, the solid wastes problem is huge, but it need not—indeed it must not—overwhelm us. In fact, I think we can feel cautiously optimistic about long-term prospects for success with the national program for two reasons. First is the growing public demand for a quality environment. And second is the fact that this demand has been translated into the Solid Waste Disposal Act, a most mature piece of legislation for improvement of the environment.

The Act, to begin with, recognizes the essential interrelationship of the three segments of pollution control. It specifically directs that in developing solutions to solid waste problems, consideration be given to how the solutions may affect not only problems of water and air pollution, but urban and metropolitan development and land use planning.

The Act, furthermore, makes it clear that solid waste pollution control involves a great deal more than disposing of solids, however safely that may be achieved. The law gives much needed emphasis to the urgency of developing

technologies which will make it possible to reduce the generation of wastes at the source, to recycle them back into production, to increase the salvage of useful materials, and to either use or convert into useful materials far more wastes than are used or converted today.

There is at least one more feature of the law which marks its maturity. This is the direction it gives Federal authorities to foster the establishment of waste disposal programs large enough to command resources adequate for the job. Fragmentation of waste disposal responsibilities among small political subdivisions sometimes running to several score in a single county, is common throughout the country and a major reason for technological backwardness in solid wastes management.

The Office of Solid Wastes was established in the Public Health Service to administer the Solid Waste Disposal Act only eight months ago. Since then, the national solid wastes program has been gotten under way in all five of the major areas of activity projected by Congress.

Grants have been made and work is being conducted on 24 research projects to lay a basis of new knowledge for progress in solid wastes technology.

Nineteen projects to investigate or demonstrate new and improved solid waste disposal systems also have received grants and work under them has been started. Several of these projects are expected to help merge small community waste disposal operations into county-wide or regional management districts. The demonstration projects are testing pilot or operational scale methods and equipment. All work of this kind is authorized to receive up to two-thirds Federal support.

Public Health Service grants under the national program also are assisting four institutions of higher learning in providing training for graduate engineers in disciplines essential to solid waste technology improvement. The present shortage of trained manpower is critical and an important factor in the technological backwardness.

Administrative and operating personnel are being trained in Public Health Service courses. In addition, solid waste training courses are being prepared under contract with the American Public Works Association.

Statewide solid waste program planning is now getting under way in 14 States under grants covering up to 50 percent of the cost of the work. It is this expanding activity which will help to develop comprehensive planning for the immediate and long-range management of solid waste problems, planning that will give appropriate but often overlooked attention to such factors as the interrelationship of solid waste management with air and water pollution abatement, urban growth trends, land use planning, and the economic and technological advantages of regional solid waste management efforts.

In the fifth area of major activity under the national program, staff and other arrangements have been made in Washington headquarters and field offices to provide local and State agencies technical assistance with solid wastes problems.

Obviously, technological development must be aimed at achieving recognized goals. In the solid waste field, these goals have thus far been expressed in rather general terms—improvement of environmental quality, protection of the public from health and welfare hazards, and improvement in the efficiency of disposal operations. These goals must be translated into solid waste management criteria which can be used as guides by State and local governments for the adoption and enforcement of standards, and by industry for the development of equipment and techniques capable of meeting such standards. The Office of Solid Wastes will undertake the development of such criteria as a major aspect of its program.

The national program intends to give solid waste technology in the United States a potent injection of the spirit of innovation. We want it in our search for new knowledge. And we want it, plus a sense of urgency, in the application of existing knowledge.

As members of this Subcommittee no doubt realize, enough knowledge is available now to significantly advance solid waste management in this country. Some of it has been available for years, yet more than half of our cities of 2,500 or more inhabitants do not yet have sanitary, nuisance-free disposal systems. All large municipalities lack, for example, incinerators incorporating available air pollution abatement technology. The principal retardation factor

has been financial inability either to buy new equipment or to risk public funds on facilities not yet wholly proven.

A national picture of the current status of solid waste management problems and practices is patently needed at this time. And steps are being taken systematically to develop such a picture. Some of the work will be accomplished, of course, in the Statewide planning surveys. But several weeks ago, to obtain an across-the-country view of the problem, the Office of Solid Wastes awarded a research contract to an experienced engineering firm for a technical economic survey of solid waste disposal needs and practices covering 450 cities and 90 industries. We are optimistic that this project, which will involve the collection and analysis of data from a very large sample of industrial and municipal sources, will be a valuable index of the total national solid waste picture.

Another research contract recently signed with the private sector calls for the development of a series of state-of-the-art reports on unit processes of solid waste disposal which could have broad applicability toward better management of the national solid waste problem.

Mention has already been made of the growing physical burden of solid wastes. The best way to lower this burden is to reduce waste generation at the source. One approach would be to design products so that the principal materials of which they are made may be recycled, or sent back, for reuse in manufacturing new products. Paper producing processes, of course, readily use wastes. And this industry could recycle considerably more wastes if solutions were found to problems of economic separation of clean and otherwise usable waste. Recycling of iron and steel scrap is a basic part of steelmaking which should, similarly, be susceptible to expansion.

The design of products for recycling materials of manufacture is a more difficult challenge. It will, of course, be rewarding in terms of solid waste pollution control. And authorities who have carefully studied the problem are optimistic that substantial recycling technology can be developed if given sufficient research attention.

In some instances, industry is now applying sophisticated technology to recover and reuse process waste materials that would otherwise find their way into the air, water, or land reservoirs as pollutants. Chemical solvents are being recovered and gases and vapors are being recycled by certain petroleum refinery and distribution facilities. And in the area of solid wastes, the lumber industry is now making marketable products out of wood scrap that would otherwise pose a very serious disposal problem.

But industry's cost consciousness cannot always be counted on to help reduce the process waste burden. Experience has shown that substantial progress frequently results from the pressure of public opinion or action by government, rather than from purely economic forces.

Perhaps voluntary action on the part of industry might occur more often if concern for potential operating economies were fortified by recognition of the fact that improper and unsanitary solid waste management costs the Nation far more than the $3 billion annually spent for collection and disposal. Industry shares in this cost burden just as surely as each citizen does. It would seem that industry, in its own interest, would recognize a much greater responsibility to develop and apply improved technology for solid waste handling in order to reduce this form of environmental contamination to the minimum.

To reduce waste production at the source, it also seems clear that research resources ought to be devoted to the design of products which generate less waste. Making some of them more durable would be a step in this direction. On the other hand, however, longevity in packaging increases the waste burden. The substitution of aluminum for steel in cans, for instance, has given us a waste item which can remain indefinitely in the environment. Many plastic containers are nearly nondegradable. We greatly need the development of paper and other packaging materials which, if they are not to be reused, are soluable or quickly degrade and can be harmlessly returned to the environment. The packaging industry has an opportunity to make a dramatic contribution to solution of the waste management problem.

In this connection, incidentally, anyone concerned about solid wastes cannot help being concerned about the apparent trend toward increased use of the nonreturnable container. Disposable bottles doubtless are a consumer convenience, but they also compound the solid waste management problem. Nonreturnable

may be presumed to have economic advantages for the beverage and other using industries. But a trend back to bottles which can be reused might be in order on the theory that cost advantages to society also are worthy of consideration.

The salvage of valuable materials and energy potentials from solid wastes offers a most promising route to moderation of the pollution problem. Obviously, solid waste salvage not only reduces the physical burden of them, but adds to the Nation's resources.

Recovering heat from solid waste incineration has tremendous possibilities which have yet to be realized in the United States. One incinerator on the east coast has produced power for water desalination. The operation of power-generating incinerators is fairly common, however, in Europe. Under the national solid wastes program, two demonstration grants are supporting experimentation with incinerator heat conversion. Meanwhile, one of the program's research projects is investigating the feasibility of producing gas for boiler fuel by heating waste.

A major problem in salvage, as already has been suggested, is economic and fast separation of usable materials from unsalvageable waste. A west coast enterprise appears to have developed an automatic separation process which efficiently separates glass, metals, and other marketable commodities. Small glass particles thus salvaged can have a number of uses, including use as plastics and industrial fillers and paint extenders. Occasionally, solid wastes can be used with little processing, as the incorporation of fly ash in building block and paving materials.

But often salvage requires fairly extensive processing to convert wastes into usable products frequently different from the starting materials. Both industry and the academic community are beginning to produce some interesting results in solid wastes conversion. Two research projects supported by grants from the Office of Solid Wastes are studying conversion through heating combustible wastes without the presence of oxygen, a process by which charcoal and coke have been made for generations. Marketable materials which may be obtained by this means include almost pure carbon, combustible gas, heavy tars, acetic acid, and acetones and alcohols. It is conceivable, incidentally, that carbon from conversion of solid wastes might be used to filter from water certain pollutants, which cannot be removed in present water treatment systems.

The use of solid wastes for land reclamation, either directly, as in a sanitary landfill, or after incineration or other processing can be considered a mode of salvage or conversion. Often the reclaimed land becomes valuable for golf courses and other recreational areas and adjacent property values are increased markedly. Three national program research projects and as many demonstration projects are directed at the development or testing of various methods of producing or using fill material from wastes without creating health hazards. Such projects would achieve, if successful, reductions in the volume of material and thus would increase capacities for solid waste disposal at landfill sites which are becoming increasingly scarce.

One such project offers the prospect of reducing landfill material from wastes to as little as one-tenth the original volume through high-pressure hydraulic compression. Another project will demonstrate a grinding process which would both reduce waste volume and so thoroughly mix the waste as to produce a fill unattractive to pests.

Composting, or the conversion of organic solid wastes into soil conditioning materials with fertilizer value, has been less widely attractive in this country than in Europe because of economic considerations and the competition of chemical fertilizers. But within the national program, composting is regarded as a promising route to solid waste disposal. The great accumulation of crop and animal wastes in areas of agricultural concentration adjacent to localities of rapid urban growth justifies taking a good look at composting. While composting may never prove to be a profitable commercial enterprise, it might produce enough revenue to help offset disposal costs.

And, of course, we want to satisfy ourselves that composting will be acceptable from the standpoint of human health protection.

One of our research grant projects is working on a method for composting fruit and vegetable refuse, without endangering health or causing objectionable odors. Other investigators are looking into possible health hazards from insecticide residues in composted agricultural wastes.

We also have under way a plant-size study of safely and economically composting municipal refuse and raw sewage sludge. This is a joint undertaking of the Public Health Service's Office of Solid Wastes, the Tennessee Valley Authority, and Johnson City, Tennessee. TVA is designing and will construct and operate a plant to process Johnson City's daily output of about 60 tons of refuse and untreated sewage sludge. The plant is expected to be completed early next year at a cost of about $750,000 and will cost around $100,000 a year to operate. TVA has had long experience in soil conditioning and fertilizing and an effort will be made to lower the project cost by finding an economic use for the product. The Office of Solid Wastes will carry out detailed pathogen studies and other health-related projects in conjunction with the Johnson City operation.

Another promising composting project has been launched under a demonstration grant from the Office of Solid Wastes. This project will test a recently developed mechanical composting plant for disposing of solid wastes quickly and without environmental health hazards. The plant is to process about 130 tons a day of refuse, garbage, sewage solids, and other solid wastes from the City of Gainesville, Florida, the University of Florida, and Alachua County. This is a cooperative industry-government venture under a nonprofit Florida corporation on which the city government, the university, and a private firm are represented. The firm developed and will build and operate the plant for the nonprofit organization.

Solid wastes technology needs improvement in at least one important area which has not yet been discussed. This is collection. Taking solid wastes from home, or industry, or farm and bringing them to their final destination represents from 70 to 80 percent of total disposal costs. This obviously is a segment of the management problem in which savings opportunities are very great. Aspects of the problem are being worked on under a research grant and as part of a demonstration project. This is where bold and imaginative innovation certainly can pay off, and we are looking at several promising ideas, including the so-called "dry sewers" for conveying solid wastes to disposal sites.

It doubtless has occurred to members of this Subcommittee that solid waste management is an extraordinarily complex problem. In fact it does not seem possible to exaggerate the complexity of interrelated factors on which judgments have to be made. Water and air pollution problems, urban and industrial development trends, recreational land use, administrative considerations, and political developments have to be weighed. Values must be assigned scientific and engineering determinations in nearly all of the disciplines. Recognition has to be given to social factors involved and the needs and resources of local, State, and Federal Governments and all elements of the private sector concerned with waste and related problems. Then there are the complexities of waste streams and seasonal and regional variations in their content. And this does not conclude the list of complications.

Fortunately, a technology of decision-making has been developed in recent years with which this Subcommittee doubtless is familiar and which should have great usefulness in developing efficient, salutary, and comprehensive waste disposal systems. The technology is management science or systems analysis, involving the use of automatic data processing, some sophisticated mathematics, and other intelligence tools. Up to now, however, despite considerable effort, it has not been possible to devise tangible inputs for systems analysis which will represent adequately some highly intangible factors—the most crucial factors of the entire equation. They may be described as social values—what the public has at stake in solid waste pollution abatement. These involve a complexity of community-wide human relationships which thus far have defied tangible expression, through systems analysis.

We have been seeking assistance in adapting systems analysis techniques to solid wastes systems development. A few months ago, for instance, the First National Conference on Solid Wastes Management considered this problem under the joint sponsorship of the Public Health Service and the University of California at Davis. We also have a research project under way with the University of California at Berkeley which we expect will provide us with some answers. In addition, we have been working with the National Academy of Engineering to develop a mechanism through which we can have the assistance of this highly competent technical organization.

With systems analysis and many other aspects of the solid waste problem we would like very much to have—we greatly need, in fact—the assistance of industry. Certain industrial concerns have acquired extensive know-how in the use of systems analysis techniques. We also need the help of those segments of industry which have been involved in the development of closed systems for recycling air and water in space craft. Industry experience with aerospace technology might well be used in the development of waste recycling systems, including solid waste systems, on earth.

Industry also has competence, probably not available elsewhere, in many other areas where new solid wastes technology so urgently needs to be developed. In problems associated with the reduction of wastes at the point of generation, for instance, industry should be able to make an outstanding contribution. Industry stands to gain when wastes are reduced, and we know that a number of companies today now incorporate waste control equipment into plant design for reasons of economics or public policy or both. Their number, unfortunately, is not yet great enough to represent a really substantial contribution to solution of the national solid wastes problem.

The Federal role in the private sector, it seems clear, is to provide incentives for and otherwise to stimulate the spread in industry of practices for solid waste pollution abatement. The national program cannot directly underwrite the demonstration of industrial hardware or finance industry research. But the program can and will buy and its grant recipients can and have bought research and technological assistance by contract. The Gainesville, Florida composting project is a case in point. Here, it will be recalled, industry not only is represented in the nonprofit corporation set up to supervise the work but has the major role in the entire operation.

There are several ways in which industry should find participation in the national solid wastes program either rewarding or desirable. Access to research and development findings stemming from the national program will be compensatory, of course, particularly where the information is useful in helping industry meet its own waste management problems. The most tangible reward, however, might occur as a significant expansion of the waste management industry. Solid wastes technology is going to advance as the program progresses. Each advance will mean new business for industry.

Government, of course, can help to accelerate the application of improved solid waste technology by specification in the equipment it buys and the installations it builds. And as time goes on and the national program moves forward, public awareness of needs for high standards in waste management will increase and with this rise will come growing recognition by industry that it too must join more fully the national effort for solid waste pollution abatement.

This Subcommittee has indicated a desire to be informed of the interdepartmental cooperation engendered and necessitated by passage of the Solid Waste Disposal Act. I should like to report that the Office of Solid Wastes has made arrangements with the Department of Housing and Urban Development whereby State solid waste planning activities and 701 planning grant activities will be coordinated through the State agencies primarily concerned with each of these programs. We have signed a formal memorandum of agreement with the Department of the Interior pertaining to our mutual responsibilities under the Solid Waste Disposal Act. I am prepared to submit a copy of this memorandum for the information of the Subcommittee.

Before closing, Mr. Chairman, I want to summarize what, it seems to me, the Federal Government ought to be expected to accomplish within the national solid wastes program as conceived by the Congress in the Solid Waste Disposal Act. The government can provide leadership and stimulation for innovation in solid wastes management and it can supply resources, not elsewhere available, for research and demonstration of improved technology. The government can help, under the national program, in acquiring knowledge where needed. It can assist in showing that prototypes of new waste management systems can provide human health protection against solid waste pollution. The government also can assist communities and States in making the best use of existing technology for solid waste management.

But the national program authorized by the Solid Waste Disposal Act can do no more than help demonstrate the desirability, even necessity, of using

new knowledge and technology to replace outmoded and inadequate practices and systems. The final steps for abating solid waste pollution will have to be taken by the people in their villages and cities, their counties and States. Undue delay, for any reason, in taking advantage of proven opportunities for effective and salutary waste management will simply make a mockery of our professed aspirations for clean air, water, and land and a reasonble share of the natural beauty upon which the human spirit thrives.

(Whereupon, the committee adjourned at 12:25 p.m., Thursday, July 21, 1966, to be reconvened on Tuesday, July 26, 1966.)

THE ADEQUACY OF TECHNOLOGY FOR POLLUTION ABATEMENT

TUESDAY, JULY 26, 1966

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT,
Washington, D.C.

The committee met, pursuant to adjournment, at 10:05 a.m., in room 2325, Rayburn House Office Building, Washington, D.C., Hon. Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. DADDARIO. This meeting will come to order.

We are pleased this morning to have with us as our witnesses two men who play an important role in this whole question of pollution abatement. We have Dr. John Tukey, from Princeton University and Dr. Athelstan Spilhaus, from the Institute of Technology at the University of Minnesota who are the authors of reports on "Restoring Our Environment," which came out of the President's Science Advisory Committee, and "Waste Management and Control," which is the work of the National Research Council of the National Academy of Sciences.

We have used these two works in our deliberations to this point. They have been extremely useful to us and we recognize that they ask many questions which are important to the society in which we live. I think that it would be helpful if you each made some opening statements and then we can ask you both some questions. Dr. Tukey, would you please start off?

STATEMENT OF DR. JOHN W. TUKEY, PROFESSOR OF MATHEMATICS, PRINCETON UNIVERSITY

Dr. TUKEY. Thank you very much. I must, I think, begin by disclaiming complete responsibility for "Restoring Quality of Our Environment." I wish I could claim it, but this was the work of a panel and I can at least say I helped coordinate their efforts.

Mr. DADDARIO. I should not have said that you were the authors but rather the chairmen of the committees which worked on both of these reports.

Dr. TUKEY. I think the first message that I must bring from the panel's long deliberations is that the problems of pollution are extremely diversified and notably interlinked. To speak of the problem of such-and-such pollution is almost an oversimplification. Problems in different places that go by the same name are often essentially different, and problems at the same place that go by different names are

often closely related. Answers, policies, or management guidelines that are well chosen for some problems are ill chosen for others. The field of pollution is very broad, inevitably complicated.

The second message is that we are all pollutors. Pollution is not caused only by the other fellow. Office buildings, schools, and homes contribute to pollution just as do agriculture, animal raising, and all kinds of industry. Pollution is not something to be eliminated. Only extinguishing the human race would eliminate it. Pollution is something to be managed, to be redirected, modified, adjusted, and lived with.

Such management cannot be confined to the management of wastes, produced whether by processes or people, without consideration of the problems their production makes. What has to be managed in the long run is the unified conduct of a civilization that has long paid little heed to disposal in comparison with acquisition. A civilization that must take a progressively more and more balanced attitude toward its environment.

To discuss here all 104 recommendations of the PSAC panel's report would be out of the question. As it would be to respond even briefly to all of the 51 questions into which your panel sharpened the issues on which these hearings are to concentrate.

Before turning to those of the 51 questions about which it seems most important for me to say something, I want to call attention to an important opportunity for industrial participation in pollution control that was not discussed in your panel's report.

As the PSAC panel worked its way through the many and diverse forms of important pollution, it acquired an increasing belief in the importance of a form of pollution rarely mentioned yet, a form of great importance to all who live or work in cities or towns. I refer to pollution by noise. Our appreciation of its importance developed at too late a date for our report to give it the attention it deserves. Since the products of industry and processes of industry combine to make most of the noise there is, it would be most appropriate for industrial research laboratories to give substantial attention to the changes in products and processes that might do the most to quiet our cities and our lives.

There is another aspect of private sector participation in guiding the management of pollution that should, I think, be mentioned here. The PSAC panel urged strongly in its recommendation B27 that the professional resources of all sectors, but most particularly the private sector, should be more deeply involved, throughout appropriate professional societies, in the development of standards, particularly I would say, systems of alternative standards rather than single take-it-or-leave-it standards. It should be more deeply involved than has been the practice in this country.

Turning now to the panel's questions, I should like to begin with question 18 from paragraph B(7):

To what extent is air pollution a problem today because the technology of abatement failed to keep pace with industrial expansion?

As I see the record, until a crisis was recognized, no adequate force pushed air pollution abatement technology to try to keep up with its challenges. And in many places these challenges have been chal-

lenges of human expansion, it seems to me, rather than industrial expansion.

The problems of air pollution are widely different in different places, not one and the same. In Los Angeles, the problem is now recognized to be mainly the automobile. In New York City, it is mainly stack emissions from heating and power generation. Throughout pollution, we must give more attention to the diversity of what seemed at first glance to be single problems.

While I must defer to experts on the promise for the future of the present R. & D. program, I stress our panel's recommendations E1 and E2 which said, and I quote:

We recommend that the Federal Government exert every effort to stimulate industry to develop and demonstrate means of powering automobiles and trucks that do not produce noxious effluents.

We recommend that the Federal Government stimulate industrial development of more economic processes for exclusion of sulfur compounds from stock effluents.

Turning now to question 28, first question in paragraph C(5):

What can be done to overcome the tendency of the present Federal agency organization to fragment research as to source or environmental sector?

Problems of combined attention to different sources of pollution do not appear to me to be as crucial today as problems involving different environmental sectors. Management reorganizations alone will do little to affect the breaking up of research and thinking by environmental sector. We need more technical ties between related work and different sectors. There is no reason why we cannot now go ahead in the way that would be presently most effective—namely, by attacking a certain number of key problems on an intersector basis.

This can be done effectively either by interagency cooperation (see panel recommendations B8, B9, and F6 for examples) or by interdisciplinary advisory studies (see panel recommendations C5, C6, and C7 for examples).

Specific intersector studies are essential, but so, too, is a forum in which the Nation's scientific and engineering communities can interact with the Federal Government's senior technical and scientific administrators. It is only through considering the broader aspects of pollution at such a level and in such a breadth that we can have an adequate chance of being properly warned of the broader problems of pollution as they come into view. In strongly urging the setting up of such a forum, the PSAC panel proposed, in its recommendation G1, a specific mechanism, interrelating the Federal Council of Science and Technology and the National Academy of Science.

Today, our deficit is in the investigation and recognition of such problems, not in the willingness of workers in different fields to join together. There are specific intersectorial tasks that are ready to be undertaken.

Turning now to questions 36 to 38——

Mr. DADDARIO. On that point, Dr. Tukey, you say there is not a lack of willingness of workers to work at these problems but rather it is a deficit in the recognition of the problems. How about the number of workers available at all levels—do you consider this as part of the problem? Even though there may be a willingness to work, is there a deficit in compatibility?

Dr. TUKEY. Well, the question of manpower is extremely serious across the whole field. But I think it is clear that there are intersectorial problems of such importance that putting some of the effort there instead of other useful and important places would be recognized as good thinking.

Mr. DADDARIO. And your point, then, is that although something needs to be done, you believe that there has developed a willingness to work so that we need not be as much concerned as some of us apparently are. Must we stimulate activity in this direction? Are you optimistic that concern has developed to the point where people do want to work in this field?

Dr. TUKEY. Let me be more precise. At the technical level, I don't know of any indication that there is not or has not been willingness. Clearly the PSAC panel felt need for stimulating activity in this area because it made a number of recommendations. We did not recommend, and I would not myself feel that management reorganizations are the way to get at this problem at the moment. I think we can stimulate intersectorial activities within the present organizational framework.

Mr. MOSHER. Can I ask for a more precise definition of intersectorial activity?

Dr. TUKEY. My impression in your panel report was that this was meant to apply to air, water, and land pollution as major sectors, and I was responding to the question in these terms.

Mr. DADDARIO. That's a correct assumption.

Dr. TUKEY. Fine.

Turning next to questions 36 to 38 from paragraph D(5):

What is required for ecology, as a science, to guide the stewardship of our environment? To what extent can ecological manipulation achieve a scientific and engineering basis? How can the value to society of our industrial economy be properly equated in ecological management?

Ecology needs more research, much of it applied to harder problems. This means more manpower—some trained in the most modern ecology, some trained in the wide variety of interacting fields, all willing to enter into collaborative work.

This will require more money, both for training and for research support, and more public emphasis on the problems toward whose solution we all need progress.

Ecology is often complex as are so many other scientific and technical fields. There is no indication that ecological problems cannot be understood. Quite the contrary. Accordingly, the question must be how fast will we develop a scientific and engineering basis for more ecological manipulation? As of today, we can clearly speed this process greatly by putting in much more effort—there are plenty of problems ready for effective attack.

The third question of D(5) with the suddent shift to "ecological management" and a special place for "our industrial economy" rather baffles me. There seems to be an undertone that the sorts of modifications in products, processes, and locations that the people may come to find worthwhile in order to restore and preserve the quality of our common environment are likely in some unspecified way to destroy our

industrial economy. There is neither historical warrant or any basis for prophecy that anything of this sort is likely, or even possible.

We have used legislative means to modify our economy many times, both by prohibition and by economic forces. Controls related to industrial health and industrial minimum wages are obvious examples. So long as we implement whatever decisions about the environment an informed public may demand, in ways that leave to our firms their traditional freedom of choosing how they operate within necessary constraints, I see no danger to our industrial economy, only a further change in its own evolving environment.

Turning to questions 42 to 44 from paragraph E(7):

Is the response of humans the proper measure in ecological management? How can environmental quality options be made subject to market appraisal? To what extent can esthetic experience be quantified?

Direct effects on humans are certainly not the only basis for decisions and balances concerning environmental quality. If our environment were much more inhospitable than it is, we would probably have to value the health of our food plants above all else, including human health. No rational environmental policy could give less than great importance to food and fiber and to all the forms of life involved in their growth.

I believe, and I am sure that the other members of the PSAC Panel join me in believing, that civilization in this country is far enough above the level of bare subsistence for its people to look upon the quality of their life as important and subject to improvement. This means that quite indirect effects on humans, either now or in the future, can properly contribute to judgments and decisions about the management of our environment and our economy.

I am a firm believer in market appraisal wherever it can be given effective play. But we must be keenly aware that many of the most vital aspects of governmental activity are not given, and so far as we can see cannot be given, market appraisal. Health, education, highways, police protection, and national defense are not appraised in any market, though we are all concerned that judgments about them are made carefully and with the best possible guidance. I see no reason why our choices about our environment do not deserve similar attention.

The valuation of esthetic experiences in monetary terms is obviously difficult. We are used to doing this indirectly, by making decisions and judgments whose consequences are those that would also flow from optimizing some expression in which these experiences would have certain monetary values, but this is far from actually valuing these experiences in monetary terms. In my own judgement, it will be a long time before we can wisely shift to much more explicit valuation of esthetic experiences. For special, often unimportant purposes, it is, of course, easy to quantify certain esthetic experiences.

Turning back now to questions 4 to 7 from paragraph A(2):

How far can new technology development proceed without comprehensive waste management systems analyses as guides to the allocation of scientific resources? What are the limitations and opportunities for systems analysis in environmental management? Is there an adequate modeling technique? Are the input data available and accurate?

I am unhappy with some of the attitudes implied by these four questions. The last three seem to suggest that we should begin by looking for model techniques and improving the input data. And only after nearly complete success with these components should we start making system analyses. On the contrary, it is quite clear that it is only by beginning some analysis in an admittedly exploratory way that we can find out enough about the true needs for techniques and input data to be able to attack their improvement effectively. Today's need is to begin to work on the job. Systems analysis can and should be valuable. They are not cure-alls. They require learning by doing.

The words, "waste management systems analysis," as used in the first question of this paragraph can easily mean both too much and too little. Some would read it as meaning systems analyses covering all of waste management. Today that is too much, for our urgent need is for systems analyses of specific problem areas. In the very near future, it will be too little because there are many problems where the systems analysis need to extend beyond waste management into other related questions. The need for a unified study of sewage treatment and water purification is already such an example.

Turning to question 13 from paragraph B(3):

Is enough of the basic environmental quality research being done in industry to establish necessary support for applied research and development?

In view of the small overall costs of basic research as compared to development, I would urge that this question be rephrased thus: "As industry undertakes more development founded upon more applied research, how much basic research should it undertake?"

There are two very strong and important conflicting pressures involved in answering this question. On the one hand, we know that good basic research in the same organization will improve both applied research and development. On the other, we know that almost every scientific subfield important to pollution is in the throes of a severe manpower crisis, one whose end is not in sight. To deflect good basic researchers completely into industry away from the critical functions of graduate teaching and undergraduate stimulation would help a little now, but hurt much in the future.

My own advice would be to so manage the industrial applied research and development program as to make it easy for industry to use basic research personnel effectively both as regularly visiting consultants and as summer or one-term full-time participants, and to encourage industry's employees to do some of their applied research at basic research centers with adequate financial compensation to these centers. It is important to us to eat our cake and still have it. We need to keep the good basic research men and women turning out students at the same time that they contribute to industry's R. & D. activities.

Turning now to question 15, the second question from paragraph B(4):

How should industrial research be allocated between process changes and effluent treatment?

If the question means how should industry allocate that research on its own processes which it itself supports, there are two simple answers: First, since each industry faces different economic balances

and technological opportunities, the answer will vary, and is best administered by individual firms or industry research associations. Second, it will not be until effluent treatment is regarded as an integral part of each industrial process, so that the distinction made in the question disappears, that we will have adequate—and adequately balanced—consideration of industrial pollution. When that time comes, product changes will also be important.

If the question is about Government-supported research in industry, then we must add at least two more areas to those in question: (1) new and better monitoring and warning devices, and (2) deeper understanding of the meteorological and hydrological phenomena as they occur in specific areas. I do not believe anyone can give a simple formula for making the resulting division into four parts. I am sure I cannot.

I do question, however, in this time of increasing public arousal about pollution, the extent to which Federal financing of research on an industry's own problems is necessary. There are undoubtedly some industries where, for financial or historical reasons, the stimulus of Federal support will be needed, but this need not be true generally. There are enough needs associated with municipal and agricultural effluents, and with effluents from other industries, to make good use of Federal funds for industrial R. & D. related to pollution in supporting work for which the industry doing the work has no obligation to do it on its own.

Turning now to question 24, the second question from paragraph C(3):

How should the distribution of research and development effort among sources and types of pollution be balanced?

While I am not prepared to speak about the question of detailed balancing between objectives, a matter that clearly deserves the best judgment we can muster, I must point out the major omissions inherent in any subdivision into "biological effects, monitoring techniques and abatement." Biological mechanisms are at least as important, and as poorly known, as the biological effects themselves. Physical problems—meteorological, hydrological, and oceanographical—are vital. Abatement must be interpreted as including the development of new ways to do things that now cause pollution.

Turning to questions 25 and 26, the first two questions from paragraph C(4):

Should Federal funding of technology development stop at the proof of principle stage or extend on to hardware prototypes and demonstrations? Should cost sharing be required in such research contracts?

In the area of municipal treatment systems there appears to be no sensible alternative for very substantial Federal support of novel demonstrations, though this could perhaps be of somewhat more of an insurance character. As elected representatives, the members of this subcommittee will understand the position that city councils and other local authorities must take about major local expenditures on untried facilities and techniques. Progress beyond a snail's pace demands collective risk taking through some form of Federal support, directed through the municipalities and other local governments.

In going beyond research to development and then to hardware prototypes we should be clear that we have passed from "research con-

tracts" to "development and prototype contracts," and that the difference is substantial.

Coming now to question 35 from paragraph D(4):

What are the possibilities for establishing meaningful cause-and-effect relationships in the environment when longtime lapses occur in 20 to 30 years?

The essential requirements that must be met now if we are to do a good job in the future of understanding delayed cause-and-effect relationships are two: Collecting now adequate benchmark data in enough widely scattered environments, and rapidly improving our knowledge of relevant mechanisms.

On the biological side we can do much today in the way of useful benchmark measurements, though we have done very little. We could do much better soon if we work much more intensively both on how to make better measurements and on that better and deeper understanding of population dynamics that is needed to guide both what we measure and how we interpret it.

The physical example of the long-term changes in the CO_2 produced by burning coal, oil, and other fuel remains in the atmosphere illustrates the situation well. We are still unable to be sure what changes in climate will follow from this increase, though we expect to know soon, since the detailed mechanisms are being actively studied through computer simulation.

Mr. DADDARIO. How soon do you expect we can come to some judgment?

Dr. TUKEY. I would not pretend to be an expert on this. What I have been told suggests that we will know very much more within the next year or two. We clearly know much more about mechanism problems now than we did 2 years ago. We are making progress on this sort of scale. The essential feature is that, as is customary when you get into pollution, mechanism simulation is not simple. The investigation of models that treat only what happens in a vertical column of atmosphere has pretty clearly proved to be inadequate, both because the self-restoring properties of the atmosphere operate on larger scales than this and because the effects of CO_2 on the general motions of the atmosphere—on the so-called general circulation—may turn out to be the important ones. As a result, one has to look at fairly complex models in order to get a satisfactory idea of what is likely to be going on. We at least now do know about the input and we also, I think, know enough about general atmospheric mechanisms so that what is being put together will give a pretty good answer.

Mr. DADDARIO. And you believe that the establishment of benchmarks in this and other areas are important so that we can come to some judgment at the earliest possible date?

Dr. TUKEY. Yes, particularly, I think, in the biological area where it is not going to be enough to know where species occur. One has got to know something about the population density and things of this sort, because it is not going to be enough to be able to say these are the areas in which certain species have become extinct.

This in many cases is almost too late or even too late. We have got to be able to follow the biological phenomena that are involved in major changes in the pressures upon species, phenomena that are often going to be reflected in changes in species numbers, rather than in

species presence or absence. Because of the tendency of life of self-compensation, we need to understand that varying levels of threats and pressure need not produce extremely noticeable changes in numbers. To identify places that are getting close enough to danger points that we should begin to think hard about action, we will have to detect rather moderate changes in numbers.

So we need not only the benchmarks but also deeper understanding of population dynamics and better ways to know how to get hold of the most helpful information, as well as understanding of what that information really means about how hard the natural populations are being pushed. I should perhaps make it clear that when I say population this means populations of anything from bacteria up to elephants and not just populations of large animals or birds.

Mr. DADDARIO. You touch on that in your report when you say that abnormal changes in animal populations, however small, must be considered.

Dr. TUKEY. There is certainly no disagreement with this. That particular quotation from the report applies particularly to the situation where we don't have the benchmarks, and we don't have an adequate understanding of the population dynamics. In general, we must take a very detective-like attitude of first trying to find any clue we can and then going on to worry about it. As we develop benchmarks—as we develop a better understanding of the dynamics—we are going to be in a better position to know what specific indications mean and thus, as a result, be able to manage things better. As it is now, when we see a suspicious sign, we may have to mobilize the equivalent of the National Guard. If we knew more about what was going on, it might be that a much smaller effort would be adequate.

Mr. DADDARIO. Thank you, Doctor.

Dr. TUKEY. Turning to questions 39 to 41 from paragraph D(6):

Is there a normal population health beyond which protection is too costly? How should environmental quality criteria reflect the special concerns for human health as to those who are allergic, sensitive, weak, sick, old, or young? Can human health effects be accounted for through an illness equivalent concept of environmental contaminants?

We have long recognized, through the provision of special environments called hospitals and sanatoriums, that the health of a certain small fraction of our population is inadequate for these people to remain in the general environment. We did not insist that the general environment be changed to meet the needs of all the sick. On the other hand, we are not prepared to treat all younger children or all older people in this way. The public would not support, I believe, a program of environmental improvement that did not consider the environment's effects on health and quality of life for people of all age groups. We will have to go far toward improving life for everyone, but we may well have to treat a few classes of people—numerically small classes of people with special problems—as exceptions requiring special environments.

Until we know much more about environmental effects than we do today, we will have to provide most of the protection for our more sensitive nonspecial groups by maintaining decently large ratios between intensities or concentrations that are regarded as acceptable and

those that have demonstrably bad effects on people at large. The importance of biological variability in sensitivity has long been clear in so many instances that we shall have to plan to allow for it everywhere where we are concerned with pollution.

There are, of course, exceptions where we already know enough to identify important sensitive groups, as in the production of methemoglobinemia in infants when drinking water contains too many nitrates (see p. 180 of the PSAC report.).

In speaking of an "illness equivalent" of environmental contaminants, we must be very careful as to how we evaluate "illness." The clinical concept is clearly inadequate for many of our environmental problems. How sick is a man who is continually bombarded by unnecessary noise? Physiological and performance tests will uncover some degradation of his performance, but they will probably grossly undervalue what such noise has done to the quality of his life. We can begin and make some useful progress with "illness equivalents" of pollution, but it will be important to keep the deficiencies of such a yardstick clearly in mind.

Question 48 from paragraph E(3):

Is area industrial development distorted by a preference for clean industries over presently known or potential polluting industries?

I would be much more concerned over distortions of environmental quality caused by fears of displacement of industry to other competitive areas when I would about distortion of area industrial development by preferences for clean industries.

Question 49 from paragraph E(4):

To what extent should zoning or selected industrial location with respect to population be used to decrease the need for effluent treatment?

The use of zoning in pollution is essential. The establishment of zones will have to be guided by differences in physical situation, differences in biological exposure, and by differences from place to place in the human purposes we want served. I would hate to see zoning regarded either as merely a means to decrease the need for effluent treatment or, at the other extreme, as only a means for setting extremely high standards almost everywhere. The purpose of pollution zoning should be to let us make a much better balance between broad public needs for a generally improved environment and the costs of extremely thorough treatment of many necessary effluents.

Mr. DADDARIO. Dr. Tukey, does that go back to one of your earlier references in which you refer to the development of a system of standards rather than a single standard? We ought not to be looking for zoning regulations which are stiff but rather those which would have some flexibility, depending upon our knowledge of the various standards and the goals that we were shooting for.

Dr. TUKEY. I think I might go a little further with that. I have prepared some comments on some of the other questions that I did not mean to read here. Let me pass on to one of those.

Mr. DADDARIO. Fine.

Dr. TUKEY. This was a very incomplete answer to question 46, the second question of E(1) about—

How can the training and equipping of local officials be coordinated with industrial pollution control personnel?

One need is a common language. I urge the development of a relatively fine-grained set of standard water and air qualities, in which amounts of various contaminants and the frequencies and combinations in which they occur are all combined together—with some choice as to weighting. At the detailed level, there may be need to go over each of the locally important contaminants separately, but if we are to have effective intercomparison of standards, both proposed and in force, we are going to need some relatively simple way of handling the very many different contaminants that may be of importance.

And let me expand on this just a moment. I am sure an expert would quote higher figures but it seems to me clear that in a major river for example, it is very easy for there to be one or two hundred different contaminants that are of some importance. Now, if we are going to have adequate discussion, and intercommunication, about the levels of quality that are being required in one place as compared to those that are required in another, I think we have got to have a common language that is much simpler than saying: "Here is a list of 200 contaminants that we dreamed up for our particular river—here are the concentrations of each that we don't want exceeded more than so many times per month, per year or per decade" and find that the place we want to compare this with has a different list of contaminating materials, has different key concentrations and has different frequencies with which they appear. This is going to make the comparison problem too difficult. I think it would, on the other hand, be an attempt to make it much too simple if we said we are going to have water quality grades 1 to 12 and prescribe just what these are for all the contaminants, epecially because the problem of making proper balances is going to be different in different parts of the country where different considerations become important—possibly even in different rivers quite close together. The only way I can see to get on with this with probable effectiveness is to have a set of standard qualities of moderate complexity where you could not only go from higher to lower quality but you could move in various directions with regard to the relative importance of different kinds of contaminants. I think if we had a framework of this sort—and this is not something that can be established easily, but it won't come about through standing still—decisions at the local level, decisions at the congressional level, decisions by administrative agencies of all sorts would in the long run be much more easily made and much more likely to reflect what people really wanted to do.

Mr. MOSHER. Mr. Chairman?

Mr. DADDARIO. Mr. Mosher?

Mr. MOSHER. What authority or agency or group or industry would take responsibility for doing this? Would it be the Bureau of Standards?

Dr. TUKEY. It seems to me this is something that is only going to be effective in the long run if it is done collaboratively.

I would say myself, that Federal Government leadership, I think undoubtedly some Federal Government financial support—and the professional societies of all sorts, the engineers, the waterworks people, and the biologists who are concerned with water, just to pick up the water side. This is not a question of saying what shall be the

rules in a particular place. This is the saying of how can we codify alternative rules so that people can think and talk about them without having to be technical experts on how much of a particular pesticide you can afford to have in river water three times a year.

Mr. MOSHER. Somebody has to take the initiative if this is a good idea. Are you suggesting that this subcommittee in its recommendations might begin that initiative?

Dr. TUKEY. I would be glad to see any competent body take the initiative on this, and I think that really pushing it forward is going to have to be a Federal initiative. The professional organizations have not had in this country the experience in participating in this sort of thing to the extent they have in other countries, notably Germany, and so we don't have a possibility, as far as I can see, of the initiative coming from there. That just leaves it in the Federal lap.

This is something that would progress slowly, would certainly have to have much revision, but I think it could provide a framework in which the actual decisions would be made more easily and better.

I would like now to turn to question 50 from paragraph E(5) which is the last one I propose to respond to explicitly.

How far should restoration of environmental quality be carried if costs and benefits cannot be appraised in a free market manner, not most hazards demonstrated to have public health effect?

As indicated in my response to D(7) the largest and most expensive functions of government are carried out without free-market appraisal; there seems to be no reason why environmental quality should be an exception. We should go as far in restoring environmental quality as an informed public is willing to be led; the Congress should take a strong leadership role.

Turning away from the questions for a moment, to mobilize the forces of the private sector it is not enough as I indicated earlier, to stimulate firms and research units. Innovations and insights usually come from individuals. It is important to arrange for as many able individuals as possible to think about ways of reducing pollution. This is one reason why serious consideration must be given to effluent charges. Once the discharge of pollutants becomes a regularly scheduled cost of doing business, proportional to the amount discharged, every technical employee can see how economically justified reductions in pollution discharges can be of real advantage to his firm, and to the technical reputation in the firm of the man who shows how they can be made.

Tax incentives are very much less broadly noticeable within a firm; moreover, they ordinarily apply to a much less satisfactory measure of depollution, to the cost of attempting pollution reduction rather than to the degree of success in reducing pollution.

Thank you for bearing with me.

Mr. DADDARIO. Dr. Tukey, your last statement is a very important one because it reminds me of some work being done in the Department of Defense in determining the benefits of some of the research funds. They were experiencing difficulty until somebody got the idea of going down to the basic level to consult with the fellow you are talking about—the one who really has to get the problem solved, and somehow solves it in an easier fashion than expected because he does have that

basic knowledge and works closely with the problem. I think that your idea of stimulating this type of person is a very good one.

Dr. TUKEY. It seemed to me on thinking things over that that definitely came within the scope of the interest of your subcommittee and these hearings.

Mr. DADDARIO. You are not eliminating, however, the fact that other incentives should be explored?

Dr. TUKEY. Not at all. Not at all. I'm just saying that this has to be considered too, and that, unless you point out this mechanism of working through the individual, I think you are likely to overlook the relationship of this sort of thing to the other ways of getting the private sector more appropriately involved.

Mr. DADDARIO. I think what we should do is proceed with Dr. Spilhaus and then we can take whatever time is left for additional questions by the committee.

Dr. Spilhaus?

STATEMENT OF DR. ATHELSTAN SPILHAUS, INSTITUTE OF TECHNOLOGY, UNIVERSITY OF MINNESOTA

Dr. SPILHAUS. Mr. Chairman, I apologize to you and members of the committee that I have not a prepared statement. I was a displaced person, displaced by the airline strike without secretarial help, and I rode a very antiquated transportation that rattled so I could neither think coherently nor write legibly.

Mr. DADDARIO. You wouldn't want to name that antiquated system?

Dr. SPILHAUS. No, sir.

Well, I, of course, reviewed Dr. Tukey's P.S.A.C. and I was involved in the National Academy report. I have read the special report on pollution to this committee by Abel Wolman, and also the report of your own panel. I think these reports are all very helpful and they naturally overlap but each has a different emphasis, so in my remarks I chose to pick out a few of the very difficult questions from these reports and then try to suggest two practical technological frameworks which might help in solution of these questions.

My remarks are not in any way comprehensive as answers to the multiplicity of questions that arise.

First of all it has been remarked many times that legislation research and technology are all hampered by an almost complete lack of information about the cost of pollution as separated from costs of disposing or treatment or cleaning up, and they are hampered because we have no measure whatever of how much people are willing to pay for physical and esthetic cleanliness. And, no way of even judging how much prevention would cost in comparison to what is spent on cleaning up after occurrence which is the way we do it now.

Housewives spend an awful lot on suds and detergents and materials to keep their houses indoors spic and span. One supposes that as public consciousness grows, people will be willing to pay to keep the outdoors clean but we have absolutely no measure of it.

And, I endorse thoroughly the idea emphasized by your own panel that we must involve private industry in this tremendous operation.

How to do it is the question; because, as they say in the report, many of the problems and the solutions have their origin in our industrial

practice. It seems to me too that, while the public health aspects are important, they have been allowed to dominate. Dr. Wolman says this in this way—he says it is not unlikely that aquatic organs and fish would be harmed long before humans. Or, putting it in another way the psychological distress of filth around us, including noise—which Dr. Tukey mentioned—may be more severe than the physiological stress.

In other words, to put it in my terms, we might go nuts before we got physically sick.

And, then there is finally this very difficult question of the need for market appraisals of environmental quality including esthetics. This is very difficult. And, governmental bodies at whatever level, have not given much recognition to this. In the condemnation of land for highways for example, if the highway doesn't happen to go right through your home, but if it wrecks the view and your peace and quiet, by going along the edge of it, there is very seldom compensation for the esthetic devaluation of the property. So, we haven't begun to approach this.

Dr. Tukey made a very important point in his comments which can be generalized a little more. The preservation of human rights is not subject to market appraisal and as has been said by some, a clean environment, a luxury now perhaps, will become a human right in the future. Education was a luxury some years ago. It is a right today. And so as Dr. Tukey said this is not really subject to market appraisal. Well, the question is how do we go about it? Are there any practical ways we can go about this, and what I am going to say are just two pragmatic suggestions, but they may be two of many ways in which we might approach, get some data on these extremely difficult, less tangible questions. It has been remarked that legislation is directed to abatement *after occurrence* and not toward *prevention* of pollution. I think that has generally been true in the past. We have got to get away from that. It is also certainly true that the research and technology in the past has been directed to *treatment* after occurrence and not *prevention* in general.

Well, there are two things that I can suggest because I believe that your committee wanted to carve out some specific areas where something could really be done in science and technology.

One of the most important points is that up to the present time in all this discussion of pollution there isn't a clearly defined goal. There isn't an exciting goal. You talk about not being able to get workers into the field. You get workers into a field where they can see where they are going, not where there is a diffuse kind of an aim. We need to sharpen our goal.

Now, when I say what the goal should be, I do not mean that we shouldn't continue to work on the basis that has gone on in the past, which is really on a crisis basis from day to day, but we need as well to have a long-term goal to work toward, on a noncrises basis toward an ultimate solution. I believe that the only goal of this kind is to aim toward recycling rather than the so-called consuming and throwing away.

I think that a well defined goal is very important. For instance, in astronautics, if we had merely said we wanted to do science in

space, science wouldn't have got very far. But, when the goal was a catchy phrase like "man in space" which could involve the man in the street in the program, it got his support. We must have a goal in pollution prevention for the man in the street to understand, that industry consumes its own wastes and that everything is reconsumed and recycled. This is maybe, a far-off goal, but it can form the focus for work on a long-term basis. It can be the aim to design at the outset with a view to recycling.

A total recycling of everything—I think this should be our goal. Of course, this needs entirely new legislative, business and marketing procedures, but because they have to be new doesn't mean that they are impossible and certainly does not mean that they are not compatible with our system of industry in the United States.

If American genius can mass produce automobiles and devise the elaborate system of distributing them, then American genius should be able to think up means of mass collection, mass disassembly and reuse. And, actually this type of thing can be done in the total context of a free enterprise operation.

It is very hard to initiate this reuse and recycling in our old cities.

In our old overgrown, overloaded cities, it is hard to do anything brand new. So, that the second practical thing that I emphasize—and it was mentioned in the academy report very briefly—is that we need a massive place for experimentation of this kind, for totally new experiments.

A broad goal like this, with huge potential benefits, justifies large experimentation, and a commensurate risk of capital. It is for this reason that I feel it is essential that we approach the idea of a new experimental city where we can really test the new technology of reuse, the symbiosis of industry, new transportation systems and many other things which can all be components in the elimination of pollution at the source. I believe that the experimental city idea would also excite people and the experimental city would stimulate industry's participation.

There was some mention made of the ecology of pollution. We need an experiment in ecology and this is what the experimental city could give us. It would give us a model for systems analyses. It would give us a way, as Dr. Tukey said, of doing while we in a parallel fashion are investigating the scientific studies for the support of the problem.

Perhaps the experimental city sounds like a somewhat fantastic idea; but it isn't. With population increasing at 3 million a year, we are essentially unwittingly building 12 cities of a quarter of a million each year in the United States, and unwittingly is right. We are not using our wits. We are just letting the cities spawn. And, while I have no figures (studies must be made on the economics), it would seem to me that it must be cheaper in the long run to build new, clean cities with new technology for these 3 million new people each year. It must be cheaper than to just allow the old ones to grow and thus multiply the old problems.

An experimental city would also be the experimental place where you could attempt new institutional practices, legislative frameworks, and so forth which are absolutely essential if you are going to utilize the new research and technology toward this goal.

The experimental city would need to have a certain freeing of attitudes of Federal Government, local government, of industry and of labor so that it could be a total experiment where you could try various incentives.

We argue about which incentive will work, but we can argue until doomsday. Why don't we try and do the experimental approach? No engineer would mass produce anything without making an experimental model. Yet, we are mass producing cities in the United States with no experimental model at all. These two pragmatic suggestions may, if they were to be explored, provide the framework in which we could answer some of the very difficult philosophical questions which I cited in the preamble of my talk.

So, I made my contribution, Mr. Chairman. I simply suggest these two practical things as a framework of doing while we continue the framework of investigation, setting standards, and developing the scientific basis that is also necessary.

Mr. MOSHER. Mr. Chairman?

Mr. DADDARIO. Yes, Mr. Mosher?

Mr. MOSHER. The only Federal City is Washington, D.C. The Congress is the city council. You aren't suggesting that the District of Columbia could be used for this experimental city?

Mr. DADDARIO. You have to tear it down first.

Dr. SPILHAUS. Without mentioning present company like the city of Washington, I would say that most of the present cities, Washington included, have gone too far in the wrong direction to be a really efficient experiment. I'm talking about a city, at a guess, of about a quarter of a million people.

Mr. MOSHER. When you talk about an experimental city, I assume that you are talking about scientific procedures, which imply controls over human behavior and human life. You are biting off something that is pretty hard to chew, aren't you?

You say this is a pragmatic suggestion. The pragmaticism of it seems a little bit difficult to comprehend. It is highly imaginative.

Dr. SPILHAUS. I don't understand. You mean this would give the impression of being too much of a controlled community and people wouldn't like it, perhaps?

Mr. MOSHER. Controlled community.

Dr. SPILHAUS. Controlled community.

Well, I think, I have thought about that——

Mr. MOSHER. Where can you get 250,000 people to subject themselves to what is implied in your proposal?

Dr. SPILHAUS. I think there must be 250,000 people who are subjected to such filthy conditions now that they would be delighted to move to an experimental city.

Mr. MOSHER. Well, OK.

Dr. SPILHAUS. And, if the experimental city was a success at all, it would have to be such that people wanted to move there and weren't forced to move there.

Mr. MOSHER. But I think you are implying rather strict control over the lives of these people. Maybe I'm wrong.

Dr. TUKEY. It seems to me these "controls" ought to be referred to in quotation marks; they would be very indirect. Garbage would be

handled in some entirely different manner, for example. Now, as long as the garbage is taken care of, most people won't regard a different manner of handling it as a severe control on their personal privileges.

Mr. MOSHER. Well, it would require certain cooperation with the individuals. However, it seems to me that you would impose certain limitations on their freedom.

Dr. TUKEY. That I think would be mainly in terms of what services were available to him and how the city were zoned and that sort of thing.

Now, these are limitations we are all used to facing when we live in any city or town.

Dr. SPILHAUS. I think one of the problems in pollution is the responsibility of every individual has not been brought home to him and so perhaps what you call controls or what might be described as responsibilities for the privilege of living in this clean city would bring home his responsibility and would prove to him that they are not so onerous, that the rewards are greater than the impositions.

Mr. MOSHER. Bringing this back to one of the main concerns of these hearings, would you have all the pollution abatement technology appropriate to such an experimental city? Do you have the technology available today to begin your experiment tomorrow?

Dr. SPILHAUS. I'm sure that all the technology is not available but as has been mentioned in more than one of these reports, there is a great deal of scientific knowledge and technology which is not being used today, and which would be the start of the experimental city. The city could then proceed in parallel with scientific and technological developments in all sections.

Mr. MOSHER. One more question, Mr. Chairman. If you were given the job of setting up this experimental city, where would the present technology be most deficient?

Dr. SPILHAUS. I think that the present technology that could be used immediately would apply to reuse and pairing of industries. I think this could be done immediately. I think transportation would be one of the things that you could do rather immediately in a new city, whereas it is very difficult to redo it in an older city.

Mr. MOSHER. Where would technology be the most efficient? Where do we need the research?

Dr. SPILHAUS. I'm not sure I can answer that question. In fact, I'm sure I can't.

Mr. MOSHER. I think that's one of the crucial questions that this committee has asked.

Dr. SPILHAUS. Yes; I simply think that if you have a place to experiment, even that question might be answered by experimentation better than by the best guess of the scientists involved in the field.

Mr. DADDARIO. In other words, we should use everything we know in this model city, such as recycling water. In this way people would become familiar with that particular idea?

Dr. SPILHAUS. That is the general idea, yes.

Mr. DADDARIO. And then you would be able to determine the gaps which would need to be filled.

Dr. TUKEY. Just the engineering and architectural studies of this sort of thing would tend to focus very much attention on places where you needed more information even before you started building.

Mr. CONABLE. Don't we have some experimental towns going up? What about Reston? This is, of course, a commercial enterprise. Are you implying that it would have to be a governmental experiment?

Dr. SPILHAUS. Reston is a very good experiment as is Columbia. These are two private enterprises. There have also been governmental cities de novo, if you like, like Oakridge and the Advanced Space Center in Houston, but all of these have been rather specific. They haven't been real cities in the sense that they involve the typical cross section of activity that we think of in an American city.

Mr. DADDARIO. If the gentleman would yield. Isn't it your idea that a city such as Reston gives demonstration projects support because it can be more progressive and imaginative than older cities? Take, for example, recycling of water. What sales effect would it have upon the people if they knew that they were going to use reconstituted water? What effect would this have? Would you not need support if it were done through private enterprise?

Dr. SPILHAUS. I have no thought that this city should be built by the Federal Government entirely. It should be stimulated by the Federal Government.

Mr. DADDARIO. With these problems in mind.

Dr. SPILHAUS. And with normal industrial and private participation in its building.

Mr. DADDARIO. Dr. Tukey, you touched on this problem of protection from noise, and you said that the work developed at too late a date for your panel to give it the proper attention, Would you touch on that a bit, considering that the President announced, in his transportation message, that Dr. Hornig would organize an Interdepartmental Committee on Noise and Abatement. The nucleus would be the FAA, and aircraft noises would be given high priority. There is some activity in the Congress, indicated by several bills which have been introduced for the establishment of an Office of Noise Abatement. We also have had some discussion in the House Science and Astronautics Committee on giving more funds for research in the field of noise abatement.

Considering all that, how would this fit into the program? What attention should we give it? Do you think that the action being taken is enough at the present time?

Dr. TUKEY. I think the point I was making about our first approach to the importance of noise in the later phases of the Panel's work was that we did not have a chance to put in the study time in this area that would have been necessary to provide the sort of foundation that I ought to have to answer your question.

And, I think I should not try to answer it. I will merely say that I think that this problem deserves study on a broader basis than crisis reaction to special problems—the aircraft noise problem is a crisis to some people. I do not know of any actually implemented attempt to take a look at noise as a whole. Where does it come from? Which sources of it could be easily reduced? And so on.

Mr. DADDARIO. But, you do bring it up because in considering this field, we must be concerned with the effects of the environment on people, along with the problem of pollution?

Dr. TUKEY. More than that, our first task of the Panel was try to formulate a definition of pollution that we could work with. The one

that we formulated—without any specific regard to noise—very definitely placed noise among the other kinds of pollution.

I agree with all the things you say, but I say both that if you try to define pollution in at all general terms, noise is there, and if you look at things that affect the quality of people's lives, noise is there too.

Mr. DADDARIO. It creeps in even though you don't look at it scientifically.

Dr. TUKEY. Even though you didn't expect it in the beginning.

Mr. DADDARIO. Dr. Tukey, I would like to touch on two parts of your committee's report and ask you to talk about them.

On page 3, in the third paragraph, in the second sentence, your report states "attempts to identify possible effects of ordinary urban air pollution on longevity or on the incidence of serious disease have been inconclusive."

And then on page 14, in the fourth paragraph, your report states: "We now know that the full effects of environmental changes produced by pollution cannot be foreseen before judgments must be made. The responsible judgment, therefore, must be the conservative one. Trends and indications, as soundly based as possible, must provide the guidelines; demonstration of disaster is not required." How do you read into all of this the fact that even though, in many areas, we have no conclusive evidence to go on as to effects, that the approach must be conservative with the idea that a demonstration of disaster is not required before we begin?

Dr. TUKEY. No, I think this sort of thing, trying to bring such points together, is very desirable.

As I take it, you are asking about the application of the rather general principles on page 14 to the specific question of long-term exposures to ordinary urban air pollution, how would I personally relate them?

The situation is approximately as follows: I think almost all the members of the Panel felt that there must be unfavorable effects from long-term exposures to urban air pollution, but were unable to find any solid evidence that this is in fact so.

The question of doing statistical epidemiological studies as to the effects of chronic influences on people is an extremely difficult one. You will still find a fair amount of discussion about the effect of cigarette smoking on human health, which is an effect that ought to be more easily measured than many pollution effects because it is caused by an individual activity. We all believe that such effects are due to the cigarettes an individual smokes and not the ones our neighbors smoke. To try to get at the effects of more pervasive, less individually attached influences such as pollution, is much more difficult.

There has been a fair amount of effort in trying to make studies of this sort directed to urban air pollution. I think that one can clearly say that these studies have shown that the effects that appear to be associated with urban air pollution are not as large as the effects that appear to be associated with cigarette smoking.

That doesn't mean that they aren't important.

I would, myself, include a concern for the human health effects of urban air pollution in coming to judgments and decisions about what we are to do about it. I would not feel that there was evidence by

which I had the right to convince somebody else that he had to be concerned. I think the situation is such that I would be glad to try to persuade him that he should be concerned.

Now, I'm trying to make a distinction here between the attitudes we all have to take when we make judgments and decisions, and the attitudes that some of us have to take when we are trying to stand on scientific evidence.

Mr. DADDARIO. Well, is this because we are not doing enough? Is this one area where we have not reached the point where the public can get excited about supporting a program because they do not know its value?

Dr. TUKEY. I think that the real difficulty here is that it is extremely hard to do this sort of study, that when you deal with problems of chronic human health you have to deal with a serious interrelation of possible causes. There are many things that can influence it. About most of them we don't know nearly enough, and it is not clear how one could at the moment make a conclusive study of this problem. I think it should be a matter of concern that we do not know better how to do this and it is a reason for being concerned with the improvement of epidemiological techniques, getting to understand how to do such things better.

The actual problem of getting hold of this specific information was not one that we felt was ripe enough that we should make a specific recommendation, though we considered this. There has been quite a lot of work done in many places, particularly in California. California State Health people have done and sponsored a fair amount of work to try to see what evidence there is about the effects of smog. It has been very hard to tie these effects down. I'm sure the people concerned really join those a little further on the outside in believing there are some very real effects, but that's a very different thing from being able to get solid evidence.

Mr. DADDARIO. But, it would certainly be a worthwhile goal even though it may be difficult.

Dr. TUKEY. Yes, and probably the appropriate steps at this time—let's see if I can find the relevant recommendation. Yes. I would say that in terms of our thinking about this problem that our recommendations G–5 and G–8 on pages 35 and 36 are the relevant ones. Under G–5 the text reads: "In particular, a variety of training grants should be provided to schools of medicine and schools of public health to support expanded programs in teaching of preventive medicine and its constituent disciplines." That is one more immediately on tooling up people.

G–8 concerns long-term support of between 5 and 10 universities to establish interdepartmental research centers for environmental studies. I think at the moment we would feel that the place where we can do the most good with this problem is to try to strengthen the tools and the people who might later take hold of it.

We did not have the feeling that the problem of health effects from urban air pollution was ripe for being seized in a large way and gone after. Good people have worked with the present techniques and we know it would be extremely difficult to get conclusive results without better ones.

Mr. DADDARIO. We do not have much time left, and I do think that we will be called to the floor. The other members of the committee should have an opportunity to ask some questions.

Mr. Brown?

Mr. BROWN. Dr. Tukey, I have been fascinated by your testimony from a number of different standpoints. My questions are largely of a philosophical nature. Could you give me some indication of the extent to which ecological science is a discipline? Are there curriculums in this field; is there training of particulars that applies to present technological societies? I would be interested to know more about this because of the emphasis that you put on the study of ecology.

Dr. TUKEY. Well, this is a question that in the long run should be directed to an expert, to somebody who knows more about this than I do. Ecology at the moment combines being a discipline, and being an attitude. What I and the panel would like, is to see both of these aspects expanded; to see the concern about the interaction between living organisms and their environment, whether made up of other organisms of nonliving material, spread through more life science.

A man can be a good ecologist and be concerned with problems of soils. He can be a good ecologist and be concerned with problems of insects. He can be a good ecologist and concerned with the problems of lakes and ponds, and many other things. It is not that there is a narrow field of study. It is that there are places where there are specifically oriented programs, and it is important to have them. But, it is also that there are people who have these interests and these competencies combined with specializations in other directions. It is most important to have such people, to have more of them, to widen this sort of interest among the specialists in the wide variety of fields.

Mr. BROWN. Well, I think that I would agree with you. It seems to me that we need to encourage this and yet because I'm remote from the academic field and particularly this field, I'm interested in knowing how and to what extent it could be encouraged. We have had some discussions in connection with the National Science Foundation in providing greater financial support to basic research to certain nonphysical sciences, such as anthropology. As far as I know, there has been little research in anthropology or ecology which has been directed specifically to the problem of an urban technological civilization; yet it seems important that we should have this kind of research.

Would you agree with me?

Dr. TUKEY. Well, I know some anthropologists who have been working on problems in urban civilization. I think it is fair, in responding to the anthropology question, to say that anthropology has been gradually and steadily working up the scale from very primitive tribes, and that a number of the good people are now concerned with societies that come much closer to our own, societies which are clearly urbanized civilizations.

There are not yet enough people who have started to tackle the problem of the sort of urbanized civilization that we live in.

But, this is the next natural step in the evolution of the interest in the field. Things are moving this way and should be encouraged.

Mr. BROWN. I raise this line of questioning because of the fact that this committee might do something to encourage greater support for

this kind of approach. Whether it is for a specific individual discipline or whether it is merely a way of looking at problems which spread through several disciplines, it needs to be encouraged and I think it should be. Getting back to ecology for a moment, it raises a question in my mind of whether or not you can draw any lines between looking at the problems with pollution and waste management for example, and the certain broader problems which you inevitably seem to lead into, for example, conservation. Where do you draw a line between the management of a river basin, for example, in order to prevent the buildup of sedimentation, the forests being cut down, the mountains washing into the river and the problem of waste or pollution management control?

Is there a dividing line or do you have to look at the total picture?

Dr. TUKEY. Well, I think it would be a mistake to have a sharp dividing line. I think you can put some differential emphasis on one thing rather than the other.

Mr. BROWN. You also have a host of political problems that you run into; for example, 3 or 4 years ago one of the big questions for political discussion was the matter of atmospheric tests and nuclear weapons. You could have looked at this pollution problem if you had wanted to, but at the same time you had a very large national defense element involved. Both of these incidentally, were not capable of being measured by the market appraisal approach.

How you weigh these sorts of problems becomes rather important.

Another interesting aspect of the trend of the testimony offered here by both of you is the degree to which it runs counter to the direction of our culture. For example, we are a consuming culture. The consumption per capita in this country is increasing on almost a logarithmic basis. This is the reason why we have waste. If we look at every process from the standpoint of how much can be recycled, it still flies in the face of the type of culture and the type of economy we have. It means, for example, that we won't produce as much because we will reuse certain products. We would also cut down on the amount of profit that certain enterprises would make because we would decrease volume. Has this type of analysis been considered by your panel?

Mr. MOSHER. Will the gentleman yield at that point?

Mr. BROWN. Surely.

Mr. MOSHER. Getting back to the experimental city, wouldn't one of the considerations be whether the participating industries would be expected to operate on a normal profit basis or whether they would have to be subsidized?

Dr. SPILHAUS. May I answer that question?

Mr. DADDARIO. Yes.

Dr. SPILHAUS. No, I don't think you need to cut down the volume of what people "consume." People consume nothing. They consume nothing now and they will consume nothing in the foreseeable future. They just use it and transform it into something and then throw it away. The only difference in my system of recycling is that it would be collected up and reprocessed. They could use much more stuff and there would be much more reprocessing done, and this could be on a perfectly good profitmaking basis. But it does require more

than a slight adjustment of marketing practices, distribution practices, but it does not cut down on an increasing standard of living, the number of things that people use can still increase. They will not consume in increasing quantities. They will use increasing quantities of things.

Mr. BROWN. I think I could take issue with that. Some of the earlier testimony indicated that perhaps the most productive approach to the problem of waste is to cut down on production. We waste more than we need to because we produce more than we need to.

For example, we could manufacture more durable articles so that they would last longer. Another example which always irks me is in newsprint production. I think that we don't need one-tenth of the volume of news pulp that we actually use, but if we took that approach, we would be flying in the face of certain cultural attitudes.

Dr. SPILHAUS. No, I think to cut down newsprint when people want this bulk of printing, would be flying in the face of the people, but to let them have as much newsprint as they want and find technologically how to rub the ink off and use it again, might be a way to provide them with even more.

Mr. DADDARIO. Dr. Tukey?

Dr. TUKEY. I think I would like to make two points, if I may. In the first place, I think I have to differ with the comment about the trend. I, of course, agree with Dr. Spilhaus, that we don't consume anything except the roughly 200 pounds that we keep in temporary storage until we are laid to rest. But, what is the trend of our civilization over the past few decades? It is the rise of the service industries. By and large the service industries are engaged in doing things for us which produce less waste than the other types. Accordingly, better waste management is entirely compatible with the way our civilization has been evolving.

Going back to your question about ecology, I would like to call attention to recommendation G–1 in our panel report where we recommend that every opportunity be seized to acquaint young people with careers in fields related to environmental pollution. I think there is a real opportunity here for trying to find ways to spread acquaintanceship with the idea of ecology and the attitudes of ecology through things that people can do as students, in particular through allowing them to participate in studies where these ideas are essential. Here there are other ways to stimulate ecology.

Mr. BROWN. I have no further questions.

Mr. DADDARIO. Mr. Mosher?

Mr. MOSHER. No more questions.

Mr. DADDARIO. Mr. Conable?

Mr. CONABLE. I have a couple of specific questions.

Dr. Spilhaus, quoting from your panel's report on "Waste Management and Control," on page 19: "In the case of water, the technology is now in hand for removing suspended and dissolved solids, and for preventing increases in total BOD loading from municipal wastes."

Can we take out a hundred percent of the BOD loading with the techniques we have now?

Dr. SPILHAUS. I think we can take out substantially a hundred percent at a certain cost. At a rather great cost.

Mr. CONABLE. Can we take out a hundred percent of the suspended and dissolved solids at a feasible cost?

Dr. SPILHAUS. Theoretically, yes, the technology is there.

Mr. CONABLE. Does secondary treatment of sewage remove 90 percent of the waste material?

Dr. SPILHAUS. I don't know. I think Dr. Wolman had better answer these questions.

Mr. CONABLE. Let me ask you the question, why is that?

Dr. SPILHAUS. First for two reasons. The attention to complete burning in incinerators is a comparatively recent thing.

Mr. CONABLE. Is this the trend of the future?

Dr. SPILHAUS. To get complete burning?

Mr. CONABLE. To do more incinerating and less carrying away of waste with water?

Dr. SPILHAUS. I don't know whether it is a trend or not, because it simply transfers waste from one section of environment into another section of the environment.

Mr. CONABLE. Is it a trade off?

Dr. SPILHAUS. It is just a trade off and in each particular case I suppose you have to figure out which is the worst. But, if you are going to put things into the atmosphere, the more complete combustion you can get, the better off you are.

Mr. CONABLE. Doesn't this mean you need higher temperatures and that the failure to incorporate the high temperature materials is due to the economics of the problem?

Dr. SPILHAUS. Yes, and possibly the same point that has been made several times by Dr. Tukey and others that municipalities are not able, under the framework under which they work as public bodies, to experiment. This comes back to the question of the need for large-scale experimentation.

Mr. CONABLE. Apart from demonstration cities, we do need substantially increased research funds, don't we, on the level of the Federal Government? Could we then make substantial advances?

Dr. SPILHAUS. I think in addition to the experimental city which is just one thing, any efforts that can be made to encourage experimentation and the use of novel technology in the redoing of existing so-called waste disposal facilities is most desirable.

Any aid that could be given to municipalities to encourage them to use the higher temperatures, better efficiencies, and incinerators would be a help.

Mr. DADDARIO. Dr. Tukey?

Dr. TUKEY. I would just like to stress that you have got to support research, you have got to support development, and you have got to support demonstration, that these are three pieces and we need all of them, even though they are quite different in their detailed character.

Mr. DADDARIO. At this point, just so it might be understood, this committee is not overly concerned with the idea of relating pollution abatement only to cost. What Mr. Conable is talking about is that if more economical means were found, they would be more attractive and therefore more cities would use them.

Mr. CONABLE. Mr. Chairman, I'm concerned that there is a tremendous demand for water and air pollution abatement in this country

now. This is a very popular cause and it is considered a proper function of government. And yet, my limited knowledge has led me to believe that we could spend a great deal of money in development in this area only to find everything was obsolete. It seems to me that we have a very specific research need right now, and one thing that I hope will come out of these hearings will be specific directions for this demand that can make the taxpayer's dollar go further toward accomplishing the end we all deem desirable.

Mr. DADDARIO. Mr. Vivian?

Mr. VIVIAN. I would like to ask a series of questions related to the topic you mentioned a minute ago; namely, the cost versus benefit problem. You have indicated, Dr. Spilhaus, that it is more desirable to prevent pollution than to clean up the pollution afterward. I think many people will concur with that.

For example, I have often wondered whether we are wise to have as many disposable glass containers as we do as opposed to either plastic, paper, or other types of containers. Glass does not deteriorate and retains its use for many years. We do recover newsprint—we have several mills in my district—but when we do the ink from the newsprint is generally sluiced off chemically and dumped into the stream. Newsprint ink, I might add, is considered to be a very difficult pollutant to handle. We even dump our waste from antipollution work. As we dig out channels, we dump waste into some other part of a lake—Erie, for example, and just transport the pollution problem elsewhere. You also mentioned noise pollution, which is a situation where perhaps it would be wiser not to create the noise than to clear up the illnesses that are generated by the noise. Do we have any kind of useful information on the cost-benefit characteristics of nonpollution versus pollution treatment?

Dr. SPILHAUS. No, I believe we don't. I believe that's one of the great gaps in our knowledge, and I mentioned that in the beginning of my statement that we simply are unable to get a comparison of cost of prevention versus cost of cleaning up.

Or, the separation of even the cost of pollution from the cost of trying to keep things clean at the present time. They aren't separated out.

Mr. VIVIAN. Do you think we are getting this? Do you believe this should be information generated by our present governmental or private activities, both research and development and operational?

Dr. SPILHAUS. I believe a great deal more effort is needed on this problem if we want to get at this cost factor.

Mr. VIVIAN. You would single this out as a specific area for increased technical effort?

Dr. SPILHAUS. Yes.

Mr. VIVIAN. I think the area of ecology merits more attention so that we may better understand biological mechanisms themselves, the complex mechanisms involved in many of these processes, whether they involve lake pollution or underground stream problems, and the population dynamics related to the mechanisms themselves; that is, transformation of the knowledge of the mechanisms and dynamics of the population. This is an enormous subject. There are a tremendous number of biological species with each species possessing great com-

plexity. I can understand and sympathize with the desire to increase our knowledge of ecology and we have some very active and able ecologists in my district, however, it seems to me that any increased emphasis in this area involves a vast expenditure of time and money. What kind of goals can one set in this enormous area?

Dr. TUKEY. I see no reason to believe that there will not, in the long run, be a large degree of generalizibility in what we find out about ecology and about population dynamics. After all, if we take another biological area for the moment, a very large amount of genetics has been done on the little fruit fly. You could have said in the beginning that there were very many species of insects, there are more species of other things. How were you ever going to get hold of genetics if you had to work with each of these spores?

The ecological situation is not as simple as the genetic one. Most but not all of life operates on roughly the same genetic pattern. (The yeasts and the molds do not use the same system as some other types of life.) We will not be as fortunate in ecology as we were in genetics to having to deal with one mechanism, but all we know about life sciences generally suggests that, if we come to understand a small number of mechanisms and how they interact, we are going to have knowledge that will be useful in a wide variety of situations.

Mr. VIVIAN. I don't intend to dodge your comment about ecology. I happen to agree with you, but my question is what do we attack first? Where do we put a priority?

Dr. TUKEY. I think that that ought to be controlled in a mixed way. And, by that I mean we ought to spend some effort in stimulating things that are directed toward specific missions and we ought to spend some effort in stimulating ecology as a whole, in letting the ecologists go where the problems seem ecologically important and ready for attack. If we don't do both of these things, we aren't going to come out well.

There are a lot of ecological problems related to pollution. A lot of these are ripe enough to be studied by present methods. If we were to emphasize ecology in the pollution direction it would be good, just so long as we supported the scientifically guided expansion of ecology in other directions at the same time.

Mr. VIVIAN. Do you suggest any particular strategy in regard to this question of ecology?

Dr. TUKEY. I think I would be glad to see more funds go into things which had some detectable relation to pollution as well as more funds generally. I think we can afford a substantial piece of mission-oriented support if we make this orientation not too strong. I think if the money was there for this, that the fact that the public is so much more interested in pollution now than it was five years ago is going to help get good people into the area.

People go where the problems are, both where problems are scientifically attractive and where problems are felt to be important. We are better off in recognized importance of pollution than we were a few years ago; we ought to take advantage of this, by providing more research money to go with the popular interest and concern.

Mr. VIVIAN. I would like to suggest one specific ecological goal or guideline.

We could try to reach the point where we have an on-line computer predicting the degree of pollution going down over Niagara Falls as a function of inputs and knowledge of ecology already available. I think it would be desirable to set up some of these on-line operations in ecology that can be tested against available reality.

Dr. TUKEY. By and large and on the whole, as a direction in which to move, this might be very interesting and helpful. I would feel that one ought to look for a much simpler system than all the waters upstream from Niagara as the place to begin. The thought of moving toward on-line checking in some places is one that I would heartily support. But if it is to be profitable, we have got to begin with situations that are easy enough for us to learn from them how to do it well and then learn how to improve, and broaden and develop our techniques of on-line prediction.

Mr. VIVIAN. Do you feel that there is a proper relationship between research and development and equipment and plant on a cost-benefit basis? Right now, as you may be aware, the Congress is considering putting another half billion dollars a year into pollution abatement. As a committee of Congress which deals with science policy, we were wondering about the amount of money we ought to put into research. Let's arbitrarily say we put a half billion dollars a year into abatement. What amount should we put into research and development?

Dr. TUKEY. There was a question about this, wasn't there? I don't know, I may not have written down comments on that. I think that one can give a qualitative reaction to this pretty well. If we think of dealing with pollution as an industry and say we are putting money into operating cost and new capital on the one hand, we are putting money into research on the other, what is the right ratio? I think the right ratio is about what it would turn out to be in those industries that are in the state of high innovation rate at the moment. If you look at the industries who have tried to find an economic alance and the ones where innovation comes rapidly and ask what percentage do they put into research as against operation and capital improvement, then this is probably about what we should be doing n pollution, because pollution ought to be a highly innovating industry for the next decade.

Mr. VIVIAN. Do you have a number on that?

Dr. TUKEY. I don't have an offhand number, but one can look at ome of the chemical industries, one can look at pharmaceuticals nd so on, and ask what people, who are trying to make money, are utting into research and development and see what would that come o if you brought it over into pollution.

Mr. VIVIAN. I wonder if perhaps your colleague is informed on hat subject. Do you have any idea what that percentage ought to e, Dr. Spilhaus?

Dr. SPILHAUS. I can only give a guess that it is in the nature of a igh figure, perhaps 5 percent.

Mr. VIVIAN. Department of Defense currently invests approxiately $5 billion in research and development and has a total operating udget of about $55 to $60 billion. That's about 8 or 9 percent.

Dr. SPILHAUS. It might run as high as that in highly innovated ndustries.

Mr. VIVIAN. The same percentage applied to roughly half a billion dollars a year under some recent water pollution bills suggests a figure of $50 million a year as a nominal amount that ought to be going into water pollution research. This is probably not enough.

Dr. TUKEY. I think that is probably not nearly enough because these percentages ought to be on both capital improvements and operating costs. The operating costs for present water pollution facilities are substantial.

Mr. VIVIAN. At the moment do you have any definite cost-benefit guidelines to use in deciding how much should go into R. & D.?

Dr. TUKEY. No.

Mr. VIVIAN. One would probably have to form his estimate, as you say, from the industries with heavy R. & D. orientation.

Dr. TUKEY. Industries in an area where innovation is proceeding at a high rate, and not the most extreme cases, but what happens in the high innovation industries in general.

Mr. DADDARIO. Will the gentleman yield?

Mr. VIVIAN. Yes.

Mr. DADDARIO. Dr. Tukey, you are only saying that this is one way to come to an estimate.

Dr. TUKEY. If I am asked to come to an estimate today, that is how I come to an estimate. At some other time I am sure other ways could be found. I think the situations are not all that different.

Mr. CONABLE. This assumes you have an adequate technology now which needs upgrading?

Dr. TUKEY. No; I would——

Mr. CONABLE. Well, no business would go into production unless it had an adequate technology to start with, would it?

Dr. TUKEY. I don't think we should spend time discussing the word "adequate," and I think that's all we would get into.

Mr. DADDARIO. Mr. Vivian?

Mr. VIVIAN. Supposing I skip for a moment to the subject of support of R. & D. in terms of total quantity or in terms of distribution between Federal and private sources and then come back to just the Federal side. In environmental pollution activities, how can we better allocate our funds between in-house research and Government laboratories and university research—nominally sponsored by the Federal Government in this case because it certainly is sponsored by other sources—as well as the question of public education, administrative controls and enforcement, and so forth. Do you have any strong feelings as to what changes should occur in distribution in research between Government-performed and Government-sponsored activity and the administrative structure that administers this research?

Dr. TUKEY. I think I will only respond to a very small part of that question and say it seems to me—it seemed to us on the Panel when we were putting our recommendations together, that there were agencies in the Government that needed the stimulation of a stronger interaction with the university and college community than they had. That not only would they be able to get research done effectively and efficiently by doing more contracting out, but that they would be able to get a better inflow of ideas and a better bringing of their problems to the attention of the generations of students as they come along, so

there are in our report some very specific recommendations about broader authority and by implication larger expenditures for this sort of thing.

Mr. VIVIAN. Let me spell out what you are saying.

You think it would be much wiser if the Government agencies spent more money for contract research at universities and other research organizations—private, profit, and otherwise—than at the Government laboratories?

Dr. TUKEY. I don't think I said that.

Mr. VIVIAN. I am trying to get you to say it.

Dr. TUKEY. I think I said that there are specific Government agencies which have not had the tradition of contract support and interaction with the universities that some of the pollution agencies—for example, Health, Education, and Welfare have had. For these other agencies it will be particularly important to develop this tradition.

Mr. VIVIAN. I want you to stop there before you weaken your argument.

Dr. SPILHAUS. Without distinguishing between in-house and out-house research, I think that where we need more Federal stimulus is what Mr. Conable was suggesting, and that is stimulus to utilize some of the better technologies that exist that aren't being utilized. This is quite apart from the research which is also necessary, of course.

Mr. VIVIAN. To return to the subject of in-house versus out-house research in pollution, I would like to come back to pollution zoning. You are suggesting finely graduated quality standards which are to be used as generalized indicators of qualities, whether they pertain to water, air, or otherwise. This brings up the problem of industry-by-industry standards which was mentioned to us last week by Congressman Vanik of the Cleveland area.

Mr. DADDARIO. That is correct.

Mr. VIVIAN. I felt much sympathy with his comments because I am well aware that industries in my own area will leave if we enforce the standards that we think we should enforce. They will go wherever the standards aren't enforced. Whether there are laws on the books or not, the question is whether they are being enforced. Do you see any conflict between what I call quality standards set by flexible codes, and industry-by-industry standards which are set on a nationwide basis rather than on a localized basis? Furthermore, do you see where we are tying this all in with a model code? You say the Federal Government could put it together, and with the assistance of the States have it adopted nationally. How do you see this pollution control operating? Do you see it as a national, local, or State operation?

Dr. TUKEY. Let me take that in pieces, if I may.

When I talking about a fine-grained set of alternative standards, that is a question of a language with which people can communicate with one another more conveniently; that is, something that is essential no matter how you attack the problem. I think I am clear that some form or other of zoning will in the long run be essential. Whether this be purely geographical or in some measure industry by industry is, I think, less important than that it come to pass in whatever way is found to be appropriate. I think that we are going

to have to maintain a pluralistic responsibility in the area of pollution: there will have to be major local decisions, and there will have to be State and regional decisions, and there will have to be some Federal decisions. Moreover, in some of these industrial problem areas, we may have, in the long run, to have Federal enforcement, if only to avoid geographic motion of industry for no other reason than local differences in pollution enforcement.

It seems to me this is a very difficult problem. It involves all sorts of economic and political questions, and I think you gentlemen have my sympathy for having to try to deal with it.

Mr. VIVIAN. Mr. Chairman, may I make one very brief comment?

Mr. DADDARIO. Yes.

Mr. VIVIAN. To the extent to which industry-by-industry standards would be not only a guide, but also a goal to industry to stimulate research and development itself in order to minimize their cost of abating pollution as well as an incentive to the installation and operation of pollution control equipment they would be beneficial. Pollution reporting today is in a very primitive state. We really have no hour-by-hour information from industries, or from any other source of pollution. I feel this is an area to which your panel might give some further attention.

Mr. DADDARIO. There are a multitude of questions that come to mind which we have just not had time to ask and which we will send to you.

I had meant, when we started these hearings, Dr. Spilhaus, to congratulate you on the confirmation by the Senate yesterday of your appointment to the Science Board of the National Science Foundation.

Dr. SPILHAUS. Thank you, sir. That's the first I knew of it. I was on the train.

Mr. DADDARIO. We are very pleased particularly because this committee has legislative jurisdiction over the National Science Foundation.

I would like to state further that, as the witnesses from the Federal agencies appear before us, we intend to see how the Federal agencies plan to implement the recommendations included in the reports which you gentlemen have submitted through the committees you chaired. In the remaining minutes I would like to touch on another point.

You both suggest in your testimony that we should use the knowledge that is available while looking for better methods for the future. And, in your report, Dr. Spilhaus, you have touched on the desirability of separating sanitary and storm sewers. The cost will be in the vicinity of $25 to $30 billion, and some people suggest that the benefits which would result might not warrant the expenditure of such large amounts. Perhaps we ought to do more research into this area before proceeding with the expenditures. Should we move ahead with such expenditures to separate sanitary and storm sewers, or should we do more research, or both?

Dr. SPILHAUS. I think you should do a little bit of each. You need, as has been said, to have research and technological, large-scale experimentation going on in parallel; each one will support the other.

Mr. DADDARIO. This is an area that we should study very carefully.

Dr. SPILHAUS. This question of division of the waters is one which I think you can't give an answer to for every place. It may be economical in certain places and thoroughly uneconomical in others.

Mr. DADDARIO. We should not just assume that a standard has been established here by the separation of sanitary and storm sewers. A value judgment must be made in each instance where this is being proposed.

Dr. SPILHAUS. I believe that is so.

Dr. TUKEY. If I could respond to that.

Mr. DADDARIO. Yes, Dr. Tukey.

Dr. TUKEY. Our recommendation B (1) reads:

> We recommend an appropriate ad hoc group of Federal, state and local officials be established to determine how best to attack the problems caused by the outmoded combined sewage systems in great cities of the United States. This group should give particular attention to research development and demonstration—

And so forth. Now, I think that it is a mistake to think of an antithesis of research on the one hand and let's go do it on the other.

I would say the combined sewer problem is in the middle somewhere. There is a real need for intensive study on a cooperative basis of the problem of where we are and of what we haven't pooled together that we know. When we do this—and it will not be easy—we will have a much better idea of where we want to go.

Mr. DADDARIO. I wanted to bring this up during the course of the public hearings because it is one point around which there seems to have developed a feeling that we ought to do something immediately and we ought to expend these vast sums.

A comparison with the highway system has been made. That is, the way you get it accomplished is by making expenditures and getting on with it. But, it is more complicated than that. You have reminded us of the recommendations you have made and I think that we should come to some better conclusions about this subject, taking into consideration what you just said, Dr. Spilhaus, and the report of your committee.

Dr. TUKEY. Well, it is an area where demonstrations may turn out to be necessary, in part as experiments to find out what both the actual costs are and what the actual benefits are.

You don't have to decide that you are going to have to do this in every city in the country in order to make it worthwhile to make what may be some very major trials.

Mr. DADDARIO. But, demonstrations should certainly come before a vast program.

Dr. SPILHAUS. Yes.

Dr. TUKEY. That would be my feeling.

Dr. SPILHAUS. Well, in the experimental city the storm water might might be so clean that you could drink it.

Mr. DADDARIO. Thank you so much for your appearance here. It has been extremely helpful to the committee, and I know we will call on you with further questions as we go along.

This committee will adjourn until tomorrow morning at 10 o'clock at this same place.

(Whereupon, at 12:25 p.m. the committee adjourned until Wednesday, July 27, 1966, at 10 a.m.)

THE ADEQUACY OF TECHNOLOGY FOR POLLUTION ABATEMENT

WEDNESDAY, JULY 27, 1966

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT,
Washington, D.C.

The committee met, pursuant to adjournment, at 10:10 a.m., in room 2325, Rayburn House Office Building, Washington, D.C., Hon. Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. DADDARIO. This meeting will come to order. Our first witness this morning is Dr. Leon Weinberger who is Acting Assistant Commissioner for Research and Development for the Federal Water Pollution Control Administration of the Department of Interior.

Dr. Weinberger, we are happy to have you here. I am sorry we are late. We will go right into your testimony.

STATEMENT OF DR. LEON W. WEINBERGER, ACTING ASSISTANT COMMISSIONER, RESEARCH AND DEVELOPMENT, FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, U.S. DEPARTMENT OF THE INTERIOR

Dr. WEINBERGER. Mr. Chairman, members of the committee, I am very pleased to appear before you to discuss research and development in water pollution control.

Mr. Chairman, I have a statement and with your permission I will read parts of it.

Mr. DADDARIO. We will appreciate that.

Dr. WEINBERGER. In the U.S. Department of the Interior, the Federal Water Pollution Control Administration carries out a program of scientific and engineering research broadly directed to: (1) The determination of the causes and effects of pollution of the Nation's water resources, and (2) the development of pollution prevention and control measures necessary to maintain the national water resources at a quality suitable for domestic and municipal water supplies, industrial and agricultural purposes, recreation, propagation of fish, aquatic life, and wildlife, and other beneficial uses. In carrying out our program, every effort is made to encourage and to cooperate with appropriate public, whether Federal, State, interstate, or local, authorities, agencies, institutions and individuals and private institutions.

Many of the water pollution problems facing our Nation today can be alleviated by the application of existing technology. In fact dur-

ing the next 5 years or so, the most significant forward strides in water pollution control will be made in this way. It is equally clear that, in addition to current problems for which there are no acceptable solutions, future population and industrial growth and concentration, changing land uses, and increased demands on our limited water resources create a situation where new technologies must be developed and applied. Problems result from the sheer mass of pollutants and from a whole host of new pollutants which are likely to be highly complex in composition and in their mode of effect.

Mr. DADDARIO. Dr. Weinberger, if I might interrupt, when you say that many of the water pollution problems facing our Nation today can be alleviated by the application of existing technology, do you mean that it can be done efficiently, effectively, and within some reasonable price figure?

Dr. WEINBERGER. Yes, sir. What I have reference to is the situation where there are still a number of locations in the United States where available treatment technology has not been applied.

In other words, there are locations where municipalities have not employed conventional primary and secondary treatment. These are processes well established and quite economical and efficient. This would apply equally well to the problem of some industrial waste where there is no treatment installed.

Mr. DADDARIO. Mr. Conable noted yesterday that there is still a great deal of work to be done in cities which already have treatment programs going. There was some question in his mind about why treatment wasn't a hundred percent effective. Is this because in this area the costs are prohibitive or is it simply an inadvertence on the part of people to do that much more?

Dr. WEINBERGER. No, sir; I think this could be explained in this way: In terms of treatment, particularly with regard to municipal wastes, what has happened in the past is that we have removed only a percentage of the impurities. This was on the basis that because the amount of impurities were small in proportion to the flow in streams, the streams could adequately dilute the residual waste and, therefore, not cause any harmful or deleterious effects within the stream. As our population has increased and industry has grown, we find that those techniques are no longer adequate, or if you will, we have overwhelmed the ability of streams to absorb these wastes. What has been developed, we called "complete" or secondary treatment which, at best, removes some 90 percent of the organic material from waste.

Mr. MOSHER. Are you emphasizing that term "at best"? Are you suggesting that frequently it doesn't do that well?

Dr. WEINBERGER. It very seldom does, sir. We are talking about reaching the limit of the process.

Mr. MOSHER. So instead of 90 percent it more likely 70 percent?

Dr. WEINBERGER. I would say in certain cases, it would be as low as 80 and could get lower than that, sir. There are many places in the United States where we do have the best treatment, which now would be biological secondary treatment which would remove 90 percent or 85 percent, sir, or somewhat less, of the organic materials and that these processes are inadequate at the present time because of the

lack of adequate dilution in our streams. This is what I refer to by just increase in the amount of pollution.

Perhaps another way of indicating this is that even with a process which is 90 percent effective, if we have a 50-percent increase in population, we are actually putting 50 percent more waste load into our streams.

Mr. DADDARIO. This fits in, doesn't it, with the idea that when you propose programs of this kind a complete program ought to be conceived rather than a 90-percent or an 80-percent or 70-percent one because the growth of population is eventually going to increase the quantity of pollutants if they are only partially treated. In a sense the funds expended can be categorized as a wasteful expenditure because they have not done their job fully. If we continue to do this always on a 70-percent, 80-percent or 90-percent basis, will we ever solve this problem?

Mr. CONABLE. Mr. Chairman, will you yield at that point? Actually, we have to strike a balance. There is a possibility that we might be able to get better and more economical treatment later, but we have to assume that if we can reduce pollution by 50 percent with existing techniques, we should go ahead and do what we can now rather than waiting for a day which may never come. Isn't this generally the consideration that we have got to take as legislators? We can't allow ourselves to be paralyzed to the point where we do nothing just because we might have a better technique sometime in the future if we apply substantial sums for research now.

Mr. DADDARIO. Recognizing the point Mr. Conable makes that we cannot always afford to wait, you would have to come to some judgments as to what areas need some treatment right away and what areas could wait, wouldn't you?

Dr. WEINBERGER. Well, let me try and answer the multiple question. One, there can be no question that we have got to have treatment technologies available that would, as I point out, result in total pollution control. This is, frankly, approaching a 100-percent removal of the impurities which man adds to the waters. This will be required in many locations and this will be required increasingly as this country continues to grow.

There are a number of processes which are available now upon which one can build. It is always a problem in terms of engineering, at what particular point one goes ahead with construction of facilities and certainly, the planning should be such that one can always add on technology to provide answers which may be needed or solutions which may be needed in the future. Thus, one of the aspects of our research and development program is to develop additional processes which may be added on to existing facilities.

A process that right now is quite promising would enable municipalities to go from their current 85- or 90-percent removal to virtually 99-percent removal of organic contaminants by adding onto their existing facilities. Accordingly, there would be no loss of investment by adding on to that particular facility. Now, on the other hand, as you point out, Mr. Daddario, there are other ways of solving the problem and that is entirely new systems for municipalities—looking into entirely new processes.

So the use of primary and secondary treatment as currently developed should not be held up pending the development of a more sophisticated or an alternate solution. These are quite economical and efficient for the removal of some of the impurities. But, on the other hand, we do have to have the techniques to go beyond this.

Mr. MOSHER. But when you are suggesting the acceptance of techniques that are not quite adequate, you certainly are not including the old storm and sanitary sewers. You have gone beyond the point where you count those acceptable, haven't you?

Dr. WEINBERGER. My comments have been directed toward the technology for treatment plants.

Mr. MOSHER. Just to answer that question, though, your Department no longer accepts as adequate the old combined storm and sanitary sewers, do they?

Dr. WEINBERGER. Our present policies are where new sewers are to be constructed, they should be separate. In other words, there should be a separation of combined wastes or the surface runoff from the community and the municipal waste.

Mr. MOSHER. They should be?

Dr. WEINBERGER. They should be separate.

Mr. MOSHER. Does this mean so far as any Federal support is concerned that they have to be?

Dr. WEINBERGER. Sir, I don't know the answer to that. I would be very happy to find out whether there is any specific regulation or how that would come to play in terms of our own legislation.

Mr. DADDARIO. Would you check on that?

Dr. WEINBERGER. Yes, sir.

(The information requested is as follows:)

Our present responsibility in the construction grants program is only related to sewage treatment works which is defined to include intercepting sewers.

Mr. VIVIAN. Would the chairman yield?

Mr. DADDARIO. Yes.

Mr. VIVIAN. I would be interested to know if you have given any grants or if any grants have been given to any combined system that was not forced to be uncombined through the mechanism of the grant. I have a second question I would like to ask, Mr. Chairman, and that is, I am interested in knowing the nature of this process which you just referred to that you said would remove 99 percent of the organic waste. How much would it cost a day? Is that information available?

(The information requested is as follows:)

If a new interceptor is to be constructed to serve an existing combined system, we would approve such a project if it conforms to normal engineering practice as approved by the State water pollution control agency.

Dr. WEINBERGER. This refers to carbon adsorption.

Mr. CONABLE. Activated carbon?

Dr. WEINBERGER. Yes, including regeneration of carbon. This has now gone through the pilot phase within our program and the current estimated cost would be somewhat less than $100 a million gallons for treatment.

Mr. VIVIAN. Is that installation cost?

Dr. WEINBERGER. This would be complete unit operating cost, including amortization of the facilities. This would be $100 per million gallons of sewage treated.

Mr. MOSHER. I thought we had some early testimony on that process which indicated that no one was sure that with actual use and in larger operating form, the results of these pilot programs would prove out. It seems to me there is some such testimony.

Mr. DADDARIO. If there is a conflict, it will be up to us to clarify.

Mr. CONABLE. Mr. Chairman, I have another question.

Mr. Vivian asked you to find out if there were any grants given for combined sewer systems. As I recall, Congressman Jones testified before this subcommittee last week that it would cost $30 billion to separate the storm sewers from the sanitary sewers in this country. I assume that we are making many grants to systems which have substantial portions of combined sewers. But I assume also that when additions are made to this system, they are of the separated form so as not to increase the size of the problem. I am sure we are making grants to combined systems, but I hope we are not making grants for extensions of combined sewer systems. I think that's the question we should ask.

Dr. WEINBERGER. Let me make a point here. The Water Pollution Control Administration in their construction grant program, where this would come up, provides for grants for the construction of sewage treatment plants and interceptor sewers. Our responsibility in the grant area, that is from the funds we administer, would be limited to the interceptor and the treatment plant itself. However, I'll see that such information as has been requested is made available and this point be clarified.

Mr. CONABLE. It is unlikely, is it not, that we will develop techniques which would be suitable for use with the combined system under all circumstances. The sheer volume of water in a combined system is likely to result in a bypass of the treatment process in the event of a heavy rain or anything of that sort.

Is it likely that we could ever develop a technique of sewage treatment which would be adequate for treatment of the flow in a combined system?

Dr. WEINBERGER. Sir, I would say that we would look for such a solution. Since the question of combined sewers has come up, we are currently working on a program which was authorized and approved by Congress last year in trying to find other solutions to the problem of combined sewers other than through separation. As was pointed out, the cost of separation may very well run into $30 billion or more, and accordingly Congress authorized funds for the exploration of alternate methods. This was in answer to Mr. Mosher's question. I indicated that at the present time the best solution of this problem is separation but we are conducting a research and development program to seek alternate ways, and one of the alternate ways would certainly be some new method of treatment or newly applied method of treatment which would enable us to treat the large volumes.

Mr. CONABLE. This would be a great deal cheaper if you could do it.

Dr. WEINBERGER. If one could do it and this, of course, is a role of research and development.

Mr. DADDARIO. This concludes the discussion we had earlier when Mr. Conable pointed out we should not wait until we have available to us all the technology. The converse, that we should not be spending money in areas where there is a chance that through research and development we can come up with a more practicable and less costly type of program, also must be recognized.

Dr. WEINBERGER. Sir, this is in any technological field a decision concerning at what point one moves ahead.

Mr. DADDARIO. We sometimes give the impression that we are moving ahead by spending money only because a program happens to be a popular one at the moment although the technology is not being advanced.

Dr. WEINBERGER. I would certainly agree with that and point out that when one moves ahead, one should plan the remedial facilities so they can be modified in the event there are some technological advances made. Whether it be in waste treatment or whether it be in the problem of combined sewers.

The analytical tools, scientific knowledge, and engineering controls which were sufficient for the problems of the past are proving increasingly inadequate in dealing with present pollution problems and will become even more inadequate to cope with foreseeable future problems. Thus, water pollution control research must develop an effective new technology while program administrators attempt to control pollution with available knowledge. It must be pointed out that in addition to research and development, there are a number of other very important elements in an effective water pollution control program, namely; competent manpower, adequate planning and administration, economic resources to construct and operate pollution control facilities, and a strong enforcement effort.

The trend in needed research in water pollution is clear. We need or will need in the near future, an arsenal of practical methods by which all man-made or man-induced impurities can be kept from our water resources. Municipal, industrial, and agricultural users of water may have to return water at a quality at least as good as that of the water withdrawn. Land users will have to modify their practices to insure no deleterious changes in the quality of runoff water. And natural processes, such as erosion, which adversely affect water quality will have to be controlled. The goal of water pollution control research is to develop these methods. When we can practice this total pollution control of municipal and industrial wastes, urban runoff, rural runoff resulting from man's activities, and natural sources, continual reuse of water will be a reality, and except in those locations where there is a large consumptive use, water shortages need not occur.

The following are some of the major practical problems and research needs in water pollution for which current technology is not adequate.

I have listed in my prepared statement, Mr. Chairman, a list of some 14 areas where there is further research and development needs.

The recent publication prepared by the Committee on Pollution, National Academy of Sciences—National Research Council "Waste Management and Control" is an excellent summary of the research needs and the status of technology for water pollution control.

As Dr Spilhaus is to be one of your witnesses, I will not go into that

Mr. DADDARIO. He was our witness yesterday.

Dr. WEINBERGER. The need for more research has virtually the unanimous concurrence of all of those concerned with water pollution control. The highest priority of research is invariably the need to develop new and improved techniques for waste treatment and specifically to develop the technology to permit more waste water reuse.

Present waste treatment methods were devised, generally, for the pollution problems that existed 40 or more years ago. Although there have been improvements in these methods, they are proving to be increasingly inadequate for the concentrations and complexities of many of today's wastes and the requirements being posed by the increased loads on receiving streams. In addition, no satisfactory methods were ever devised for many industrial wastes and some of the impurities found in municipal wastes.

Water supply and pollution trends show that one of the most pressing problems in water quality management is the need to develop new treatment processes which will remove much more of the pollutional material from municipal and industrial wastes than is possible by present biological methods. The volume, strength, and complexity of future wastes can only result in the discharge of larger and larger amounts of impurities into badly needed water resources if we continue to apply presently known treatment processes only. The sole currently available solution, in many cases, would be low flow augmentation, that is the provision of dilution water from upstream artificial impoundments.

Each water-use adds increments of wastes that are not removed by biological treatment. If we are to meet our future water needs, as seems inevitable, through repeated reuse of our fresh water resource, much more of the impurities must be removed from waste streams. To do this, new treatment processes are being developed, based, in some cases, on concepts and principles that will achieve complete conversion of waste waters to fresh waters. This will require a major research program and the best scientific minds in government, industry, and universities. It will require the utilization of physicists, physical chemists, chemical engineers, and virtually all other scientific resources not yet fully brought to bear on water pollution problems.

The Nation has already entered the water reuse phase but increasing needs will require multiple reuse of the same waters, particularly in the water-short Southwest and the Southwest-Pacific areas and in the highly populated and industrialized areas of the Midwest, Northeast, and Middle Atlantic.

Multiple reuse of water will not be possible unless much more economical, effective, and efficient waste treatment processes are developed than those available now. These will need to be basically new processes, probably utilizing chemical and physical techniques.

The object of our water purification and reuse program is to develop these new treatment processes—this has been referred to as advanced waste treatment. More broadly, the goal is to develop a new arsenal of treatment tools which will permit not only total pollution control but also deliberate, controlled reuse of water. Reuse, greatly augmenting our natural fresh water supplies, will be possible

through recharge of ground waters with treated waste effluents and, more directly, through the complete renovation of waste waters for deliberate recirculation in municipal or industrial water systems.

More answers to more difficult pollution problems can be achieved through a successful water purification and reuse research program than through any other research.

Answers are required now and more will be required soon in reaching decisions on the need for expenditures of billions of dollars on:

(a) Design and construction of municipal and industrial waste treatment works.

(b) Storage of water in Federal reservoirs for regulating stream flows for water quality control.

(c) Storage of water in Federal reservoirs for municipal and industrial water supply purposes.

(d) Source development for public water supplies; and

(e) Importation of water from water-surplus to water-short areas.

The development of a successful advanced waste treatment technology would have a tremendous impact on our whole water resource problem. These techniques could conceivably allow the development of "dry" industries and municipal treatment plants from which absolutely no pollution would enter our surface or ground waters; these processes could completely change our present concepts of "adequate" waste treatment and could drastically reduce the otherwise necessary expenditure of multiple billions of dollars for provision of low flow augmentation dilution water to reduce pollution from presently untreatable wastes; advanced waste treatment could allow continued economic growth and development in water-short areas of this country whose future developable water supplies are presently limited. In short, a successful advanced waste treatment technology, by renovating waste waters for deliberate reuse, would simultaneously alleviate two of our major water resource problems—water pollution and water supply.

The solution of water pollution problems will require the application of existing techniques, plus additional research and development for new and improved techniques. Research and development generally goes through a series of steps ranging from exploratory studies through laboratory research, field evaluation, and demonstration. In the past, our efforts have been mainly in laboratory research and there has been a recognized deficiency in the application of research findings. The application of research findings requires that someone undertake the construction and operation of new type facilities which are often very expensive and which are associated with a greater risk of failure than with processes which are already proven in practice. The construction of remedial facilities in water pollution control is the responsibility, to a considerable extent, of local authorities who may have limited financial resources. Often these authorities feel that they cannot afford the risk associated with trying new methods. It may very well be in the best public interest for the Federal Government to design, construct, and operate full-scale facilities to develop and demonstrate new ways of pollution control. Such facilities could be built in cooperation with existing or new municipal installations or at Federal installations.

The competencies and expertise of private industry must be enlisted in the research and development programs for water pollution control. Legislation currently under consideration by the Congress would greatly facilitate our ability to utilize the industrial resources by authorizing suitable funds for contracting.

We are very optimistic that our water pollution problems can be solved. In fact, we must be able to control pollution if we are to continue our national growth, prosperity, and well-being. With adequate budgetary and legislative support, total water pollution control can become a reality long before the end of this century. Indeed, major scientific and technical answers can be available within a decade.

Mr. Chairman, that completes my statement and I will be very pleased to answer any additional questions.

Mr. DADDARIO. Thank you.

Mr. Vivian?

Mr. VIVIAN. I would like to come back to the question which you posed earlier; which I mentioned is repeated in your statement a number of places. That is, there was a distinct tie between the methods of treatment and the extent to which augmentation would be required. Suppose a city which is now using a typical secondary treatment plant anywhere from a few years to 10 years, or 20 years, vintage desires to upgrade the quality of its effluents to avoid the search for the source of supplemental water at low flow portions of the year. What additional cost would a city incur and would there be any likelihood of significantly reducing it in the visible future rather than the unforeseeable future?

Dr. WEINBERGER. The treatment which could be added on, and our effort in the past has been directed primarily to improving existing facilities, by such a municipality would most likely make use of something such as activated carbon. And the cost, which I previously indicated is our best estimate based upon our pilot plant work, of such facilities would be in the neighborhood of $100 a million gallons.

To indicate what this means in magnitude, I might point out that the present sewage treatment cost for the conventional biological treatment would be between $50 and $200 a million gallons.

Mr. VIVIAN. That is approximately doubling the cost of an existing facility?

Dr. WEINBERGER. Yes, sir.

Mr. VIVIAN. The operating cost as well as the capital cost?

Dr. WEINBERGER. Yes, sir. Capital cost as well as operating cost would be roughly doubled. I might point out that the figure for operating cost which I am giving includes amortization of the capital cost over a 20-year period of time which is what we normally figure.

Mr. VIVIAN. However, is the result of doubling the cost, that the residual wastes are reduced by a factor of about 20? In other words, say from 85 or 90 percent to roughly 99 percent?

Dr. WEINBERGER. Yes, sir. This is an extremely important concept that when one goes from 90 to 95 percent removal, although it appears that there is only a 5-percent increase in efficiency, you actually have reduced by 50 percent the load which you are putting on the stream, and if you go from the 90 to 99 percent, you are actually reducing the load on the stream by 90 percent.

Mr. CONABLE. Does this activated carbon process have any effect at all on the inorganic waste?

Dr. WEINBERGER. No, sir.

Mr. CONABLE. Do we have techniques for removing such things as phosphates and other chemicals dissolved in water?

Dr. WEINBERGER. Sir, we do have some processes but again I must hasten to add as pointed out in my statement that with the funds available to date most of the Federal effort has been in the laboratory and some in the pilot stage. There are processes which we are investigating for the removal of inorganic materials. Some of these are in cooperation with the Office of Saline Water and some of the techniques which they are developing we are interested in applying; such things as reverse osmosis, electrodyalisis. A problem is lowering the cost of the treatment facility.

Mr. CONABLE. But this technique for instance would have no appreciable effect upon the algae problem in the Northeast; would it?

Dr. WEINBERGER. No, sir, the removal of phosphates and nutrients would be not affected in the carbon adsorption.

Mr. DADDARIO. You mentioned the figure of $5 million to be allocated for research purposes. Could you give us here or provide for the record the amount you have asked for fiscal year 1967?

Dr. WEINBERGER. Yes, I would be very happy to provide that for the record.

(The information requested is as follows:)

Fiscal year 1967 budget request is for $3,150,000.

Mr. VIVIAN. I have no further questions at this time.

Mr. DADDARIO. Mr. Conable?

Mr. CONABLE. I have no further questions.

Mr. DADDARIO. Mr. Brown?

Mr. BROWN. No further questions.

Mr. DADDARIO. Mr. Mosher?

Mr. MOSHER. The Governor of Ohio, Governor Rhodes, has recently indicated his impatience with the progress in our State in pollution control and has announced a proposal that he plans to submit to the legislature for the direct treatment of polluted streams within the streams themselves. He is talking about the State's instituting a program which would include aeration devices, neutralization equipment, oil skimmers, debris traps, and other such facilities for use in the streams.

Would those devices be included in the technology that you suggest exists today and which should be applied? If the State of Ohio wanted to spend the money for these devices would it be well spent?

Dr. WEINBERGER. Sir, I couldn't comment on the individual stream, but some of the techniques for example——

Mr. MOSHER. You mentioned individual streams. As you know, in Ohio, there are many types of streams with different problems.

Dr. WEINBERGER. What I am trying to get to here is some of the techniques that he refers to, for example, the actual cleaning up of debris, this, of course, is bound to be effective in performing its task.

There are methods available for in-stream aeration. These have met with limited success even though devices are available, and one would have to look at a particular situation in terms of the stream

velocity and flow and the amount of waste coming in. A technology is available—it is a question of its applicability in a particular situation.

Mr. MOSHER. Aren't you really saying that each stream in an individual case?

Dr. WEINBERGER. Yes, sir.

Mr. MOSHER. This goes all over the country. Each stream or river has to be considered as a separate case. You can't establish standards or techniques which would be applicable everywhere.

Dr. WEINBERGER. Yes, sir, and this has been the policy of the administration to recognize that this is so.

Mr. MOSHER. To go back to my original question, assuming that the State applied these techniques judiciously and wisely on the basis of stream-by-stream studies, would these techniques be effective and would the State be wise in pursuing these measures?

Dr. WEINBERGER. Yes, sir. As a matter of fact, one of the areas that I mentioned for which R. & D. is needed, is in my 12th point on page 5—in-stream treatment.

Now, again I think there is a question here of alternates which must be compared. Whether the in-stream treatment is more suitable or effective than treatment at source.

In other words, in-stream treatment assumes that we are unable to control the waste at the source or it is not economically feasible to do so. Therefore, what we do is take the entire stream and treat it in that way.

This is why I say this would depend on an individual analysis as to what one is doing.

Again, I might take one example of this. For such a pollutant or pollution from a diverse source like acid mine drainage, it might very well be that it would be more economical if, one could not control the waste at the source, to treat the entire stream.

Of course, it is always preferable, if the economics permit, to control at the source which would prevent the degradation of our streams.

Mr. MOSHER. On page 3 of your statement you suggest that land users will have to modify their practices to insure that there are no deleterious changes in the quality of runoff water. I'm told by some people that one of the problems we have in Lake Erie—and that's the situation of particular interest to me—is the amount of nutrients that run into the lake from heavily fertilized farmland. Apparently, the erosion of farmlands into the scores of streams and rivers that go into Lake Erie cause the nutrients to be deposited there. You say that land users will have to modify their practices. Is there much work being done along those lines? Obviously land erosion has been a problem that has been of interest and dealt with for years, but is there new thought being given to it?

Dr. WEINBERGER. Yes, sir; there is.

We have worked with the Department of Agriculture in terms of insuring that one does not apply fertilizers in excess. In terms of such things as pesticides for example, considerable progress as you know has been made in terms of application, to assure that the minimum required dose is applied and the dose is applied effectively. Pesticides are not used in excess which would then end up in our streams.

Mr. MOSHER. In other words, in this complicated and difficult problem of Lake Erie, one of the controls conceivably would be the

regulation of the use of fertilizer. Is that true? Would you assume that the political authorities in their effort to cope with Lake Erie's problem ultimately would have to regulate the amount of fertilizer that the farmer puts on to his field?

Dr. WEINBERGER. I haven't thought out the legislative procedures of effecting this type of operation, but in certain cases one is going to have to regulate erosion, nutrients, pesticides, and so forth.

Now, how this is accomplished, Mr. Mosher, I don't know.

Mr. DADDARIO. Isn't research being conducted with new types of fertilizers and insecticides which would decompose more readily and lessen stream pollution?

Dr. WEINBERGER. Yes, sir; the idea of applying materials that would be retained in the soil so they would remain where they are needed.

Obviously any of this material that runs off into the surface streams or the ground water streams or in the lake is not doing the job it should.

Mr. DADDARIO. Mr. Waggonner?

Mr. WAGGONNER. The primary work that the Government is doing now under Public Law 566, which the Department of Agriculture administers, involves small watershed projects. An integral part of this legislation includes a provision which takes into account the farmer's watershed on his land in the development of any small watershed project. The experience they are getting can be applied in a much bigger way to existing projects such as Lake Erie.

The Government is participating now in exactly this sort of thing under Public Law 566. This is one of the reasons that some of us opposed the conference report on watershed projects last week from the Department of the Interior. Since none of this was taken into account in giving authority to the Department of the Interior to usurp Public Law 566.

Mr. DADDARIO. I might add that you opposed it succesfully, Mr. Waggonner.

Mr. WAGGONNER. Yes, sir; and that doesn't happen too often.

Mr. DADDARIO. Mr. Conable.

Mr. CONABLE. Dr. Weinberger, do you think that too much emphasis is being put upon organic materials in considering municipal waste control? Is there any statistical comparison available which would show the significance of inorganic and industrial waste in our water pollution problem? Because of the evolution in technology, our industrial processes are changing. Does this tend to pollute our streams with new inorganic material? Can't this be considered the great problem of the future and the one for which we are unprepared?

Apparently most of our techniques of water treatment are designed to remove organic waste. Do you have any statistical comparison or any comments to make?

Dr. WEINBERGER. Well, I would certainly agree, and again I must apologize for perhaps shortening my statement, but in terms of the development of new treatment techniques, on page 4 I indicated the classes of impurities, and, of course, one of the classes is certainly dissolved inorganic substances. You are quite correct in pointing out that the major problem of the future is unquestionably going to be in the area of dissolved substances, and particularly in dissolved inorganics and the persistent or nondegradable materials.

We have information related to what these might be in municipal wastes. We have paid very little attention in the past because there was no need to be concerned with the removal of the inorganic substances in municipal sewage.

Dissolved inorganic materials are becoming critical in some locations.

Sir, I do not believe that statistics are available which would indicate what is the magnitude of the industrial waste problem, whether it be organic or inorganic, but quite clearly you are correct that major emphasis must be placed on dissolved materials.

Mr. DADDARIO. Mr. Vivian?

Mr. VIVIAN. I am interested in a statement you made in this regard. You have indicated that you have about $4 million worth of outstanding proposals which have not been funded. Do you have any estimate as to what fraction of these you would be happy to fund if you had the funds available at the present time?

Dr. WEINBERGER. I would say at least half of these, and perhaps even more would be the kind of projects that should be funded in a program that is trying to come up with answers during the next 5 to 10 years.

Mr. VIVIAN. Would it be possible to expand present research activity by 50 percent without any growth of the profession itself?

Dr. WEINBERGER. I would like to evade that and point out the reason for my making this particular point was that we think the program can be expanded considerably more than 50 percent. These proposals have come to us with the people who are submitting proposals recognizing there are no funds or very limited funds available. We have not been in a position to fully utilize the industrial competencies and the other contracting sources which one might go to.

Mr. VIVIAN. What fraction of these proposals are from Government as opposed to Government laboratories?

Dr. WEINBERGER. The $4 million are virtually all from industrial sources.

Mr. VIVIAN. You are building new Government laboratories in various parts of the country?

Dr. WEINBERGER. Yes, sir.

Mr. VIVIAN. One is being built in my own district. I would like to know what amount of additional money is needed. What are your operating costs?

Mr. DADDARIO. You can provide that for the record.

Dr. WEINBERGER. All right.

(The information requested is as follows:)

The Great Lakes Laboratory to be constructed at Ann Arbor is currently under design. Two and one-half million dollars has been authorized and appropriated for the design and construction of that facility. Until designs are completed and bids and construction contracts are received, we shall not know whether any additional funds are needed for construction. The operating costs—when the laboratory is fully staffed (approximately 150 people), is estimated at two million dollars per year.

Mr. DADDARIO. Mr. Brown?

Mr. BROWN. Do your activities include the funding of what might be called engineering development for promising technologies which may have been discovered by independent inventors?

Dr. WEINBERGER. Yes. My responsibilities include our Division of Engineering Development, and in the prepared remarks I tried to indicate that this is going to be a very important part of our program, and, of course, is really the end point of research, and without this, one has research findings which are not applied.

It is this particular area in which the funds are required and which the current legislation would enable us to do the engineering development and rely as we would expect to a considerable extent on industrial contracts.

Mr. BROWN. What is this current legislation that you refer to?

Dr. WEINBERGER. This is the bill that has passed the Senate in the Public Works Committee, the one that Mr. Muskie introduced and the administration bill. The bill passed the Senate some 2 or 3 weeks ago. I don't have the number on it, sir, but it is the amendments to the Water Pollution Control Act. It is 2947. Senate 2947.

The companion bill is H.R. 16076.

Mr. BROWN. Is it anticipated that these bills will pass in the near future?

Dr. WEINBERGER. The hearings are being held, sir, or they have been completed.

Mr. DADDARIO. Mr. Davis?

Mr. DAVIS. I noticed on page 9 of your statement that you have itemized some answers that will be required and in B you say, "Storage of Water in Federal reservoirs," for one purpose, and C, "Storage of water in Federal reservoirs," for another purpose.

I wonder if your conclusion was based upon an assumption or a study of the matter indicated to you that the States and the municipalities would probably not be able to finance the construction of a reservoir?

Dr. WEINBERGER. I didn't have any implication here that the State or otherwise constructed reservoirs wouldn't also fall into this.

It so happens that the responsibility of our administration is at the present time limited to Federal reservoirs.

Mr. DAVIS. Have you ever studied the ability of a municipality or State to raise the required funds for the construction of reservoirs?

Dr. WEINBERGER. Sir, I have not.

Mr. DAVIS. I don't mean to overemphasize this point, but I think that the committee ought to look into it considering the political implications involved.

Do you have any information concerning charges by a municipality or State upon an industry for polluting a stream? Have you had any contact with that practice?

Dr. WEINBERGER. I have not, sir. Others in the administration might, but I have not in my research and development responsibilities.

To our knowledge, no State has legislation which allows for the payment of a fee for the discharge or dumping of wastes into receiving bodies of water. There are a number of States which do have a permit system.

(The statement concerning the treatment for phosphorous removal requested by the subcommittee is as follows:)

The principal objectives in waste treatment practice have been the removal or destruction of suspended and floatable solids, dissolved degradable organic

material (the oxygen-demanding substances), and disease-producing microorganisms. Existing treatment processes are only moderately successful in removing nitrogen and are generally ineffective or unreliable for the removal of phosphates. Nitrogen and phosphorus are nutrients for algae and the discharge of these substances can significantly contribute to the nuisance conditions associated with "algae blooms."

A number of treatment methods for the removal of phosphates are under study. These methods include:

1. Chemical treatment for the precipitation of the phosphates. This method can be quite effective. Chemical costs are moderate but a sludge disposal problem is created.
2. Phosphate removal by deliberate growth of algae under controlled conditions. The problem here is separation and disposal of algae.
3. Ion exchange—still in laboratory stage.
4. Soil treatment—Certain soils can effectively remove phosphates. Laboratory and pilot studies are underway.
5. Biological treatment—A number of investigators have reported that certain biological treatment plants are quite effective for the removal of phosphorus—the removal being considerably in excess of that to be expected from cell synthesis. A dramatic example of this phenomenon has been observed at the San Antonio, Texas, treatment plants. One plant here has a high removal of phosphorus, one a low removal, and the third intermediate and variable removals. It appears that all plants treat sewage of generally the same composition. Investigators from the Federal Water Pollution Control Administration have analyzed the situation and are now conducting research. Studies to date indicate that it may be possible to design and operate—what are otherwise conventional treatment plants—for effective removal of phosphates. Laboratory, pilot plant, and full-scale plant studies are currently being initiated to determine costs, potentials, and limitations of his method of phosphate removal.

Research underway with potential for significant technological development in waste treatment within five years:

1. Granular carbon adsorption for removal of dissolved organic substances.
2. Powdered carbon adsorption for removal of dissolved organic substances.
3. Phosphate removal by:
   (a) Chemical means
   (b) Algae
   (c) Ion exchange
   (d) Soil treatment
   (e) Biological treatment
4. Nitrogen removal by nitrification—denitrification.
5. Sludge disposal by spreading on and reclaiming of strip mine areas.
6. Polyelectrolytes for removal and concentration of suspended and colloidal solids.
7. Reverse osmosis for removal of inorganic pollutants.
8. Electrodialysis for removal of inorganic pollutants.
9. Ion exchange for removal of selected impurities, e.g., inorganic nutrients.
10. Chemical oxidation for destruction or organic substances.

Mr. DAVIS. Mr. Chairman, I think that this is an area that bears some scrutiny on the part of this committee. As the Chairman is aware, there has been increasing talk of user fees in many areas of government service, and I would think that sometime in the future it might be possible to exact a fee at the Federal level upon industries who do introduce pollutants into a stream.

Mr. DADDARIO. Following Mr. Davis' point on Federal reservoirs, would you eliminate either of the alternatives suggested here or the opportunity for States to act in concert?

Dr. WEINBERGER. No, sir, my entire presentation here is directed toward the technical problem.

Mr. DAVIS. I understand that.

Mr. DADDARIO. Mr. Waggonner?

Mr. WAGGONNER. Is the natural use of the term "Federal reservoirs" a result of your responsibility in interstate work?

Dr. WEINBERGER. Yes, sir.

Mr. WAGGONNER. It carries no special significance?

Dr. WEINBERGER. None whatsoever. The question has appeared before other committees of the Congress concerning the Federal role in State-financed reservoir construction. My reference was just limited to the fact that this is within our current act.

Mr. DADDARIO. It is an important consideration, however, and I'm pleased that Mr. Davis has pointed it out.

Mr. Roush?

Mr. ROUSH. Dr. Weinberger, one of the reasons for my excitement about the national space endeavor concerns the spinoff. We are very much aware that as we plan these trips to the Moon and other planets, disposal of waste and the matter of clean air within the capsule is very important. We also know that the National Aeronautics and Space Administration is directing some of its attention to that particular problem.

Has anything unusual come to your attention as a result of their technological endeavor in this regard?

I imagine that someday we will have home devices as inexpensive and common as a garbage disposal which will take care of the home waste problem.

Dr. WEINBERGER. The only reason for hesitating was your question about whether anything unusual. There has been an interplay between NASA and ourselves. As a matter of fact, we make use of their contract reports in terms of any possibilities of technology being developed.

As you point out, there are obvious similarities in terms of a closed capsule, if you will. They are reusing and are actually treating water to be reused. So whatever techniques they develop there, not only in terms of treatment, but analytical methods or sensors or any other technology, we are alert to.

Some of their work is in biological systems which we have been working in concert. But, the concept you mention of taking household waste and perhaps treating them in other ways, yes, this is clearly one of the approaches which an R. & D. effort in this very expensive, necessary program of pollution control ought to be engaged in.

Mr. ROUSH. You have answered my next question which is, do you have contact with the people engaged in this work within NASA?

Dr. WEINBERGER. Yes, sir.

Mr. ROUSH. Thank you, Mr. Chairman.

Mr. DADDARIO. Dr. Weinberger, I hope we may be able to send some questions down to you or have some of our staff contact you.

Dr. WEINBERGER. I would be very pleased to do that. (Additional questions and answers for the record may be found in volume II).

Mr. DADDARIO. I appreciate your coming here this morning. You have been extremely helpful.

Dr. WEINBERGER. I appreciate the opportunity to be here. (The biographical statement and complete prepared statement of Dr. Leon W. Weinberger follows:)

BIOGRAPHICAL STATEMENT ON DR. LEON W. WEINBERGER

Born and raised in New York City. BS, CE from the Cooper Union, MS and DSC from Massachusetts Institute of Technology in Sanitary Engineering.

Professional affiliations and honor societies

Fellow, American Society of Engineers, Water Pollution Control Federation, Member of Society of the Sigma XI American Water Works Association.

Professional history

1966—Present Assistant Commissioner, Reearch and Development, Federal Water Pollution Control Administration, Department of the Interior.

1963–1966—Chief, Basic and Applied Sciences Branch, Division of Water Supply and Pollution Control, Department of Health, Education and Welfare.

1957–1962—In charge of sanitary engineering program and Director of Research Laboratory at Case Institute of Technology.

1949–1962—Associate Professor of Civil and Sanitary Engineering at Case Institute of Technology.

1949–1962—Consultant in water supply, waste water disposal, and stream pollution to city, State and Federal Governments, and over 20 industries.

Has authored more than 50 scientific papers.

PREPARED STATEMENT OF DR. LEON W. WEINBERGER, ACTING ASSISTANT COMMISSIONER, RESEARCH AND DEVELOPMENT, FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, U.S. DEPARTMENT OF THE INTERIOR

Mr. Chairman, members of the committee, I am very pleased to appear before you to discuss research and development in water pollution control.

In the U.S. Department of the Interior, the Federal Water Pollution Control Administration (FWPCA) carries out a program of scientific and engineering research broadly directed to: (1) The determination of the causes and effects of pollution of the Nation's water resources, and (2) The Development of pollution prevention and control measures necessary to maintain the national water resources at a quality suitable for domestic and municipal water supplies, industrial and agricultural purposes, recreation, propagation of fish, aquatic life, and wildlife, and other beneficial uses. In carrying out our program, every effort is made to encourage and to cooperate with appropriate public (whether Federal, State, interstate, or local) authorities, agencies, institutions, and individuals.

My presentation is concerned mainly with research and development in the technological aspects of water pollution control. It is, of course, important to recognize the need for scientific information on the water quality requirements for all water uses (the effects of pollution) and the economic and sociological aspects of water pollution control.

Many of the water pollution problems facing our nation today can be alleviated by the application of existing technology. In fact, during the next five years or so, the most significant forward strides in water pollution control will be made in this way. It is equally clear that, in addition to current problems for which there are no acceptable solutions, future population and industrial growth and concentration, changing land uses, and increased demands on our limited water resources create a situation where new technologies must be developed and applied. Problems result from the sheer mass of pollutants and from a whole host of new pollutants which are likely to be highly complex in composition and in their mode of effect.

The analytical tools, scientific knowledge, and engineering controls which were sufficient for the problems of the past are proving increasingly inadequate in dealing with present pollution problems and will become even more inadequate to cope with foreseeable future problems. Thus, water pollution control research must develop an effective new technology while program administrators attempt to control pollution with available knowledge. It must be pointed out that in addition to research and development, there are a number of other very important elements in an effective water pollution control program, namely: competent manpower, adequate planning and administration, economic resources to construct and operate pollution control facilities, and a strong enforcement effort.

Needed research

The trend in needed research in water pollution is clear. We need or will need in the near future, an arsenal of practical methods by which all man-made or man-induced impurities can be kept from our water resources. Municipal, industrial, and agricultural users of water may have to return water at a quality at least as good as that of the water withdrawn. Land users will have to modify their practices to insure no deleterious changes in the quality of runoff water. And natural processes, such as erosion, which adversely affect water quality will have to be controlled. The goal of water pollution control research is to develop these methods. When we can practice this total pollution control of municipal and industrial wastes, urban runoff, rural runoff resulting from man's activities, and natural sources, continual reuse of water will be a reality, and except in those locations where there is a large consumptive use, water shortages need not occur.

The Committee on Water Resources Research of the Federal Council for Science and Technology has established a number of categories for classifying research. The primary research effort of the Federal Water Pollution Control Administration is in Category V—Water Quality Management and Protection. The subcategories are: A. Identification of pollutants; B. Sources and fate of pollution; C. Effects of pollution; D. Waste treatment processes; E. Ultimate disposal of wastes; F. Water treatment; and G. Water quality control. In addition, research in water resources planning is carried out.

The following are some of the major practical problems and research needs in water pollution for which current technology is not adequate:

1. In treatment, new and improved processes, equipment, instruments, chemicals, and systems for all types of waste streams or sources to provide for:
   (a) Removal of suspended solids
   (b) Removal of dissolved organic substances
   (c) Removal of dissolved inorganic substances
   (d) Complete disinfection of waste effluents
   (e) Waste water purification to qualities suitable for direct deliberate reuse
   (f) Disposal of impurities removed from waste streams
   (g) More effective control and operation of facilities
2. Treatment and control of storm and combined sewer discharges
3. Retardation and reversal of accelerated eutrophication (the over-fertilization of lakes and other waters which results in nuisance organisms and vegetation)
4. Improved analytical tools to identify and measure pollutants
5. Methods to assess the effects, subtle and gross, chronic and acute, and ecological, of pollutants on all uses of water
6. Control of pollution from non-point sources for example:
   (a) Agricultural runoff including irrigation return flows
   (b) Acid mine drainage
   (c) Salt water intrusion
   (d) Construction activities
7. Methods to treat wastes in small or isolated disposal systems
8. Control of pollution from boats
9. Methods to measure and control the effects of impoundment of water on the water quality
10. Planning techniques for water pollution control systems
11. Assessment and evaluation of socio-economic factors in water pollution control
12. In-stream treatment
13. Methods for determining the fate of pollutants in lakes, streams, bays, estuaries, and ground water
14. Manufacturing and product changes to reduce pollution at source.

The recent publication prepared by the Committee on Pollution, National Academy of Sciences—National Research Council "Waste Management and Control" is an excellent summary of the research needs and the status of technology for water pollution control.

The need for more research has virtually the unanimous concurrence of all those concerned with water pollution control 1] Federal, State, and local governments, 2] scientists and engineers, 3] conservationists, 4] industry, and 5] managers and operators of water and waste treatment facilities. The highest prior-

ity of research is invariably the need to develop new and improved techniques for waste treatment and specifically to develop the technology to permit more waste water reuse.

Waste treatment

Present waste treatment methods were devised, generally, for the pollution problems that existed 40 or more years ago. Although there have been improvements in these methods, they are proving to be increasingly inadequate for the concentrations and complexities of many of today's wastes and the requirements being posed by the increased loads on receiving streams. In addition, no satisfactory methods were ever devised for many industrial wastes and some of the impurities found in municipal wastes.

Water supply and pollution trends show that one of the most pressing problems in water quality management is the need to develop new treatment processes which will remove much more of the pollutional material from municipal and industrial wastes than is possible by present biological methods. The volume, strength, and complexity of future wastes can only result in the discharge of larger and larger amounts of impurities into badly needed water resources if we continue to apply presently known treatment processes only. The sole currently-available solution, in many cases, would be low flow augmentation, i.e., the provision of dilution water from upstream artificial impoundments.

A good part of the municipal pollution problem may stem from the common conception of today's "complete treatment." The use of the phrase has been very misleading to the taxpayer and perhaps even to the technician.

What is accomplished by today's complete treatment? A fairly good job is done in removing oxygen-consuming materials, generally 75 to 90 percent removals are attained. About the same removal is accomplished with respect to suspended materials. In these removals another problem, not yet satisfactorily solved, is created: what should be done with the separated sludge? The algae nutrients, nitrogen and phosphorous, are removed to a very limited extent. Only a fraction of some of the dissolved organics is removed and essentially none of the increment of dissolved inorganics added to water during use is taken out. This has been called *complete treatment* and the receiving stream has been relied on to complete the job through dilution and so-called self-purification. Unfortunately, as water demands increase, dilution water becomes, proportionately, less available and self-purification mechanisms are largely ineffective against the very same classes of contaminants which have successfully resisted treatment.

Each water-use adds increments of wastes that are not removed by biological treatment. If we are to meet our future water needs (as seems inevitable) through repeated reuse of our fresh water resource, much more of the impurities must be removed from waste streams. To do this, new treatment processes are being developed, based, in some cases, on concepts and principles that will achieve complete conversion of waste waters to fresh waters. This will require a major research program and the best scientific minds in government, industry, and universities. It will require the utilization of physicists, physical chemists, chemical engineers, and other scientific resources not yet fully brought to bear on water pollution problems.

The Nation has already entered the water reuse phase but increasing needs will require multiple reuse of the same waters, particularly in the water-short Southwest and the Southwest-Pacific areas and in the highly populated and industrialized areas of the Midwest, Northeast, and Middle Atlantic.

Multiple reuse of water will not be possible unless much more economical, effective, and efficient waste treatment processes are developed than those available now. These will need to be basically new processes, probably utilizing chemical and physical techniques.

The objective of our Water Purification and Reuse Program is to develop these new treatment processes (Advanced Waste Treatment). More broadly, the goal is to develop a new arsenal of treatment tools which will permit not only total pollution control but also deliberate, controlled reuse of water. Reuse, greatly augmenting our natural fresh water supplies, will be possible through recharge of ground waters with treated waste effluents and, more directly, through the complete renovation of waste waters for deliberate recirculation in municipal or industrial water systems.

More answers to more difficult pollution problems can be achieved through a successful Water Purification and Reuse Research Program than through any other research.

Answers are required now and more will be required soon in reaching decisions on the need for expenditures of billions of dollars on:

a. Design and construction of municipal and industrial waste treatment works.

b. Storage of water in Federal reservoirs for regulating stream flows for water quality control.

c. Storage of water in Federal reservoirs for municipal and industrial water supply purposes.

d. Source development for public water supplies.

e. Importation of water from water-surplus to water-short areas.

The development of a successful advanced waste treatment technology would have a tremendous impact on our whole water resource problem. AWT techniques could conceivably allow the development of "dry" industries and municipal treatment plants from which absolutely *no* pollution would enter our surface or ground waters; AWT processes could completely change our present concepts of "adequate" waste treatment and could drastically reduce the otherwise necessary expenditure of multiple billions of dollars for provision of low flow augmentation (dilution) water to reduce pollution from presently untreatable wastes; AWT could allow continued economic growth and development in water-short areas of this country whose future developable water supplies are presently limited. In short, a successful AWT technology, by renovating waste waters for deliberate reuse, would simultaneously alleviate two of our major water resource problems—water pollution and water supply.

Although a greatly expanded research and development effort is planned, the total Federal expenditure for research to develop new treatment technology through FY 1966 has been less than $5 million. Under this funding, however, it has been shown possible, at laboratory and pilot-scale plants to achieve *any* degree of waste treatment desired and, in fact, to return a waste water to a quality at least as high as that of the water before use. Much research and development work remains to be done, however, before these degrees of treatment can be accomplished at any necessary location, under any necessary conditions, and at the lowest practical cost. These efforts require resources—funds, facilities, personnel, and time.

Even without any active solicitation of proposals for research projects in this area, a backlog of some $4,000,000 in proposed but unfunded projects now exists. This illustrates, in some small measure, the high level of interest in this problem among industrial, academic, and governmental research scientists and engineers.

An increased rate of effort to completely develop presently known processes and also to explore and develop new processes and process modifications could be carried out. To the present time, approximately 35 separation or ultimate disposal processes have been considered. Of these, approximately 10 or 12 have been rejected while the rest are at some stage of feasibility determination, engineering development, or process evaluation. It can well be expected that about 10 to 12 new approaches will be considered annually and that 3 or 4 of these will deserve investigation to at least the engineering development stage.

The average cost of completely developing a process might be $9 to $10 million. These development costs, however, are not unreasonable in light of the annual costs of 1 to 2 billions of dollars spent in constructing municipal and industrial waste treatment plants and in the even greater amounts of low flow augmentation costs and storm sewer separation costs which could be affected directly by these research findings.

Our experience has demonstrated the great importance and efficiency of conducting simultaneous and complementary in-house and contract research projects. It has also shown that the over-all effectiveness of contract research can be very greatly enhanced through the intensive application of technical direction, coordination, and monitoring. A contract support staff of engineers, scientists, economists, and other professional personnel must provide continuing planning, data interpretation and analysis, and system optimization services to the program by using the most up-to-date techniques and principles, such as operations research, critical path analysis, and cost engineering. This staff must also solicit the interest and ideas of the most competent scientific and engineering minds in the Nation; encourage the submission of proposals in light of the over-all broad attack on the problem; monitor, direct, and coordinate projects in progress; and interpret and evaluate results and recommend continuance, termination, or redirection of the work. The Staff must also conduct adequate liaison with other agencies and organizations, both within and without the Fed-

eral Government. For these reasons, we believe it to be of the utmost importance not to "cut corners" with respect to either numbers or competence of research staff.

It has also been proven extremely valuable to use Cooperative Projects Agreements with various local authorities to allow actual plant-site studies by both in-house and contract researchers. Such installations have been initiated at Cincinnati, Cleveland, and Lebanon, Ohio, at Lancaster, Pomona, and Whittier Narrows, California, and here at the District of Columbia. Other such field sites will be used when appropriate.

Field Evaluation, Demonstration, Experimental, and Model Plants

The solution of water pollution problems will require the application of existing techniques, plus additional research and development for new and improved techniques. Research and development generally goes through a series of steps ranging from exploratory studies through laboratory research, field evaluation, and demonstration. In the past, our efforts have been mainly in laboratory research and there has been a recognized deficiency in the application of research findings. The application of research findings requires that someone undertake the construction and operation of a new type facility which is very often very expensive and which is associated with a greater risk of failure than with processes which are already proven in practice. The construction of remedial facilities in water pollution control is the responsibility, to a considerable extent, of local authorities who may have limited financial resources. Often these authorities feel that they cannot afford the risk associated with trying new methods. It may very well be in the best public interest for the Federal Government to design, construct, and operate full-scale facilities to develop and demonstrate new ways of pollution control. Such facilities could be built in cooperation with existing or new municipal installations or at Federal installations. Examples of full-scale projects which may have to be built or financed to assure an effective water pollution control program are:

1. Latest techniques of waste treatment.
2. Methods to control nitrates and phosphates which cause fertilization of lakes; included would be procedures for removing these nutrients from lakes and streams.
3. Methods for handling, conditioning, and disposal of impurities removed from waste streams.
4. Systems for waste water purification and reuse including ground water recharge.
5. New processes for industrial waste treatment to serve as models to industry and State regulatory authorities on how pollution can be reduced and controlled in an economical manner.
6. In-stream treatment methods.
7. New instruments for surveillance and operational control.
8. Methods for control of pollution from combined and storm sewers.
9. A total waste management program in a model community including construction of needed facilities.
10. Methods for water conservation.
11. Control of irrigation return flows.
12. Control of acid mine drainage.
13. Methods to prevent boat and ship pollution.

Acceleration of research

There are a number of elements necessary to carry out a research program. These include:

1. Manpower
2. Facilities and equipment
3. Funds
4. Time

It goes without saying that the most critical element is the manpower. Here, I am most concerned with the creativity aspect. A successful program depends on ideas and imaginative methods by which these ideas can be developed and applied. The role of funds, facilities, and equipment is perhaps the best understood, although it is well to point out that whereas funds are necessary to carry out a program, an increase in funds does not necessarily result in a proportional increase in output of results. The time necessary to accomplish

a particular research objective can sometimes be shortened by increased funding but at a greater overall research cost. The acceleration of research into a crash program may be a necessity, and water pollution control research may fall into that category.

Can the manpower be obtained to carry out an expanded water pollution control research program? Based on the evidence at hand, we can conclude—yes! Many segments of industry have demonstrated a capacity and willingness to engage in contract research. University researchers are showing a greater interest in conducting water pollution control research. The staffing of our laboratories has not been slowed by lack of qualified candidates (although attracting senior scientists and research administrators may become a problem in the future). An extremely important factor in attracting research interest has been the demonstration that water pollution control is a real, major problem for which we must have answers.

The competencies and expertise of private industry must be enlisted in the research and development programs for water pollution control. Legislation currently under consideration by the Congress would greatly facilitate our ability to utilize the industrial resources by authorizing suitable funds for contracting.

We are very optimistic that our water pollution problems can be solved. In fact, we must be able to control pollution if we are to continue our national growth, prosperity, and well being. With adequate budgetary and legislative support, total water pollution control can become a reality long before the end of this century. Indeed, major scientific and technical answers can be available within a decade.

Mr. DADDARIO. Our next witness is Col. Alvin F. Meyer, Jr., Chairman, Environmental Pollution Control Committee, Department of Defense.

We welcome you here, Colonel Meyer, and I'm sure Mr. Waggonner would like to welcome you as a constituent and old friend.

Mr. Waggonner?

Mr. WAGGONNER. Thank you, Mr. Chairman.

I would like to extend my personal welcome to a longtime friend and constituent from Louisiana, Colonel Meyer. I don't know how many of the people have a copy of his statement, but I just noticed that the colonel was born in 1920 in Shreveport. Looks are deceiving at times. He looks a good bit older than I do, even though he isn't.

Colonel Meyer is a very personal friend of mine and I want to emphasize to the committee that he is an example of a man who seeks to serve the needs of the military and his country in deference to personal considerations.

Colonel Meyer is a man who by no means finds it necessary to be employed by the Federal Government or any branch of the armed services because he has accumulated through his own efforts sufficient means to provide for his personal needs. Because of the desire to serve his country he remains in the military. I think his record speaks for itself, and I think the testimony and statement he will give to us this morning will certainly explain what I mean.

It is good to have you here with the committee.

STATEMENT OF COL. ALVIN F. MEYER, JR., CHAIRMAN, ENVIRONMENTAL POLLUTION CONTROL COMMITTEE, DEPARTMENT OF DEFENSE

Colonel MEYER. Thank you, Mr. Waggonner, I appreciate your very flattering and complimentary remarks.

Mr. Chairman, members of the committee, staff, and visitors, the Department of Defense appreciates the opportunity to appear before

this committee, and to participate in its hearings on the adequacy of technology for pollution abatement.

Sir, this morning I have with me in addition to my members of my DOD and Environmental Control Committee, some technical advisers who will be available to answer those questions which may come to the committee's mind which requires some technical information.

With your permission, sir, I should like to at least cite the names of these people, although time is running short. There is Captain Riblett of the U.S. Navy.

Lieutenant Colonel Taft of the Office of the Surgeon General, U.S. Army.

Lieutenant Colonel Peterson, Office of the Surgeon General, U.S. Air Force, and Lieutenant Colonel Hippler from the Office, Deputy Chief of Staff, Research and Technology, U.S. Air Force.

Lieutenant Commander Hernandez, who is representing the Surgeon General of the Navy.

Major Shaw of the Surgeon General's office of the Army.

Mr. Kinney of the Department of the Navy, and Captain Chapman of the Surgeon General's Office, U.S. Air Force.

These gentlemen are here, sir, not only to answer any questions which the committee might have which I feel would be better answered by technical experts, but also to somewhat serve as an evidence that the Department of Defense has a deep and abiding interest in this study.

We have studied with much interest the report of the Research Management Advisory Panel on this subject. As you know, we have provided the committee with a résumé of our observations on the "issues" enunciated in the Advisory Panel's report. That summary discusses those issues about which we have views as results of our experiences, and those on which, because of their implications to the military departments and agencies, we feel that our observations may be of value.

It does seem appropriate, as a point of departure in this discussion, to emphasize that the military departments' concern for the prevention of adverse environmental effects is no new development, brought into being in the last few years. While it may not be necessary to reiterate to this committee the leadership which military preventive medicine has exhibited in the past century, it is worthwhile for the sake of the record to point out that military leaders have long been concerned with the effects of preventable disease and injury on their military capability.

Many current practices in civil environmental sanitation and public health are reflections of the innovations and leadership in applying the then available technology to the needs of military personnel in the field, aboard ship, and in garrison. Thanks to an awareness of the importance of proper waste disposal, maintenance of the best practicable—and I stress practicable—level of environmental sanitation in adverse situations, combined with an application of immunology and the best clinical practices, the death rate from illness in World War II was actually lower than that of the civil population, being on the order of 1 per 140 persons on active duty, versus 1 per 100 in civilian population.

Mr. Chairman, as an aside, I might point out that in the Civil War the ratio of illness and death to persons on both sides engaged was 1 to 11.

This traditional awarenes of the importance of the environment has been vastly expanded since World War II. Modern technology has resulted in the evolution of complex military systems with a wide variety of potential hazards to the health and effectivenes of military personnel. The modern military community is a complex of industrial and technical facilities with all of the problems of civilian urban industrialized areas.

The military departments have an abiding interest and responsibility to insure that their operations do not result in a degradation of effectiveness, and that harm to adjacent civilian communities does not result.

Careful perusal of the testimony given by Department of Defense witnesses appearing before various congressional committees over the past several years will provide an insight as to the depth of concern and scope of action taken. It is significant that departmental policy on this subject has been formalized in DOD directive 5100.50, "Environmental Pollution Control," which among other requirements specifies that environmental pollution control will be included in military system programs, and that appropriate research thereon will be undertaken. This directive provides policies and responsibilities relating to environmental pollution control at every level of the Defense Establishment.

We have rather extensive experiences in matters concerning the more traditional problems of air and water pollution and solid waste disposal at military installations, and in approaching the problems of hazards associated with new systems. There are four primary areas having a bearing on the "issues" suggested in the Advisory Panel's report, upon which some comment in this summary appears to be appropriate.

These are:

First, the matter of goal setting, and the resultant need for better approaches to the establishment of criteria, and the relation of both of these considerations to legislative and regulatory requirements;

Second, the utility of the systems management and systems analysis concept to the pollution problems;

Third, the possibilities for adaptation of military and space technology to the environment of the future; and

Fourth, the question of scientific basis for pollution policy.

With regard to the first of these, it is in order to point out that the Department of Defense has more than an incidental interest. The military departments and agencies have a clear mandate to comply with local and State requirements as to air and water pollution, and are charged with the requirement of "exhibiting leadership" on these problems.

Being thus subject to the necessity for developing programs involving large-scale expenditures of public funds, the Department is naturally concerned regarding the means by which the requirements in this regard are to be specified. The beryllium rocket propellant program, shipboard waste disposal, and the disposal of waste from munition manufacturing operations are typical cases where requirements have had to be established, even without completely valid technical

bases. In dealing with these we have accumulated considerable experience in the role of technology in establishing environmental quality values.

There is emerging a clear-cut need for better technology in resolving the complex socio-economic-political considerations affecting environmental quality requirements. It is easy to be "against air and water pollution," and demand that something be done regarding solid waste disposal. It is relatively more difficult to ascertain just what should be done in the wide variety of situations involved in the man-environmental relationship.

In the press for demonstrable progress, there may develop overemphasis on enforcement of requirements which may not adequately provide for the future. There is a lack of knowledge or perhaps ability, to quantify in rational terms the "metes and bounds" of acceptable environmental quality. Inherent in this problem is the fact that living organisms, including man, possess a wide range of adapability to environmental stress. In only a very few instances are there sharply delineated boundaries between truly harmful, and absolutely safe conditions. This being so, when dealing with the problems of intrusion into the environment of adverse physical, chemical or biological agents, there must also be given an accounting to the questions of the utility of the environment to various sociological ends. Some of these may have no bearing on health, or individual well-being, but may be related to economic utility as the case of effects on shellfish industries, or to satisfaction of esthetics as in the case of protection or preservation of natural beauty.

Mr. DADDARIO. Do you believe we have done enough work to sharply delineate these boundaries you mentioned between truly harmful and absolutely safe conditions? I recognize we must take into consideration these points you have put before us but I wonder if we know what the cumulative impact of some of these effects in our environment will have on man and how do you adapt this philosophy to the situation which confronts us?

Colonel MEYER. Well, Mr. Chairman, there are extremes, of course, that you can define. One can truthfully state what concentration of certain chemical substances will kill fish, for example. You can come up with that value. You can also find what concentration of cyanide in water will affect human beings.

Similarly in the air situation you can indeed define what concentration of carbon monoxide, if inhaled for a certain number of minutes will produce death or illness or demonstrable changes in the human body.

But, below these upper limits, there are a wide range of changes which the body can adapt to and accommodate to and it is in this area that we get into the problem of definition of environmental quality. This is a very complex problem and one, sir, also which involves more than demonstrable physiologic damage.

Later on in this discussion we touch a little bit upon the subject of cost versus benefits, and also in our prepared statement we have in the more detailed report some information on this subject of the need for considering these things.

Mr. DADDARIO. When we were preparing ourselves for these hearings we met with certain scientists and industrial leaders, including Dr. Wiesner, and he pointed out that there were a few parts per million of DDT in our bodies. This is not considered harmful and yet nobody has begun to develop a method of determining whether in fact it might become harmful if we accumulate more. Therefore, in order to establish ourselves properly within the criteria you have placed before us, we should not assume that the presence of DDT isn't harmful just because we aren't dying from its effects.

Colonel MEYER. This, sir, is the thrust of these remarks that there is a need for greater exercise of research in this area.

Now, in the field of industrial toxicology as you know, there is a considerable effort. Some of the things which we are doing in the space program with regard to environmental quality standards for space cabins involve extensive long-term chronic toxicity studies to undertake this very question because the human body does indeed have certain detoxification capability, certain adaptive capabilities which we need to know more about.

Mr. DADDARIO. Perhaps I am overly concerned with the emphasis you put on the word, "practicable." What you mean is that we ought to do everything we can now, but at the same time we must watch the danger signs and develop techniques which don't presently exist.

Colonel MEYER. Yes, sir.

Mr. DADDARIO. We ought not carry this question of being impracticable too far.

Colonel MEYER. I would agree with your statement, Mr. Chairman that what we are saying here is the following: That there are some things that we clearly can discern as being problems and that there may be techniques to approach the solution of those problems in a rational and carefully planned manner recognizing those areas about which you do not have adequate information.

But, that in doing this, and in our comments further regarding our approach to the systems analysis application, you identify those levels of knowledge that you have and where you need to expand your research efforts, but being sufficiently flexible that you can indeed make the necessary changes in your larger program and in your techniques.

One has to take a look—this has already been alluded to in some other testimony before this committee also—to foreseeable changes. Now, Dr. Abel Wolman, who is one of the profession which I belong to, a most distinguished person, is going to appear before this committee and I recollect that approximately 25 years ago Dr. Wolman published a paper as a result of investigations conducted by the American Association of Railroads on the problems affecting disposal of human waste from railroads. As you know, the general procedures was and still is direct discharge onto the tracks.

As a result of considerable concern by the Public Health Service and others as to possible contamination of water waste by trains passing over bridges and also by effluents being discharged through the natural course of water running over the ground and into the receiving streams, is a problem.

This morning, sir, New York Central announced that it is stopping passenger service of over 200 miles. I suspect it would have been difficult 25 years ago to have predicted that the technology of transportation was going to completely eliminate a major area of concern over a large part of the United States which was of interest at that time. Yet, as they move down the scheme or course of events, it has become evident in the last years that railroad traffic was diminishing. I cite this as a need for the flexibility of administrators, of scientists, and of political leaders in keeping pace with the development both in the situation with which they are concerned and also with the evolution of technology.

Mr. DADDARIO. When the Department of Defense needs some timely, available technology, it makes arrangements with industry to do certain research and development. Should we go that far in a field such as pollution abatement? Should we require industry to come up with some answers to some of these problems that you believe require solution?

Colonel MEYER. Mr. Chairman, I believe so. I can only cite the experiences of this Department in that this question of both near-term and long-term pollution control in all aspects, not just air or just water, but as an integrated system, is an essential part of our systems analysis, and our systems program. I'm not sure that all of the techniques that are involved in systems programing can be utilized to come up with all of the answers to this very complex problem, but I'm sure that there is much to be learned and much utility in the application to this problem of these techniques, sir.

Mr. DADDARIO. Should we be more careful about making heavy expenditures before more work is done in the research field and researching the problem more thoroughly perhaps than we have at the moment?

Colonel MEYER. I would concentrate, Mr. Chairman, on the clearly identifiable problems which are within our capability to identify and to assess what are the most economic methods of approaching those identifiable problems. At the same time I would undertake to apply oth an analysis of what is needed in the way of improved technology and begin to estimate how this will fit into what I would consider to e the problem 5 and 10 years from now. Yes, sir.

Mr. DADDARIO. Mr. Waggonner?

Mr. WAGGONNER. Aren't we getting back to Dr. Weinberger's testiony concerning improved analytical tools? Can't we only do what ou suggest after we have developed with some degree of certainty hese improved analytical tools to measure these tolerances which you peak of?

Mr. DADDARIO. It seems to me that this point is threading itself hrough these hearings, Mr. Waggonner. Regarding the estimated xpenditure of $25 to $30 billion for the separation of storm and sanitary sewers, it appears that we ought to be expending such funds but hat we ought to be doing in that area what we know is best and nalyze the problem so as to see if we can develop better techniques to ccomplish that. And, I expect that's really what you are saying.

Colonel MEYER. Yes, sir.

Mr. WAGGONNER. But, only after we have the available technology.

Mr. DADDARIO. The colonel has emphasized, however, that we should not hestitate to apply available technology in those situations where it may be extremely helpful.

Colonel MEYER. That is correct, sir.

Mr. WAGGONNER. For example, we passed legislation last year in the field of treatment devices for automobile exhausts. Perhaps we were a little early. I had the feeling it was something that needed doing but nobody demonstrated to us during the consideration of that legislation that we had developed the capability at that point to provide effective devises for automobile exhausts. We felt that after a period of time if we placed the burden on them, they would come up with solutions.

Mr. DADDARIO. We will have an opportunity to look into and examine the point you have just raised, Mr. Waggonner.

Mr. MOSHER. Mr. Chairman?

The colonel has just referred to identifiable problems. It is frequently alleged by people in my district that the Army Corps of Engineers is one of the worst polluters of Lake Erie. I am referring to the dredging of sludge from harbors and rivers and dumping it into Lake Erie. I don't want to get into a discussion on it here, but I think it would be important, Mr. Chairman, to ask the Corps of Engineers or the Department of Defense to respond to that allegation. Can we request the Department of Defense to send us their views as to what extent they are polluters and what they might do about it?

Mr. DADDARIO. I'm sure we can.

I think that information is and can be made available.

Colonel MEYER. Mr. Chairman, this subject was brought up at hearings that Congressman Jones had last week, in Rochester. Rather than addressing myself to the answer to this question, I'll request that information for the record and the answer to your question, sir, will be furnished immediately. You will get it.

(The information requested is as follows:)

STATEMENT BY BRIG. GEN. ROY T. DODGE, USA, DIVISION ENGINEER, U.S. ARMY ENGINEER DIVISION, NORTH CENTRAL CORPS OF ENGINEERS, CHICAGO, ILL.

Mr. Chairman, I am pleased to represent Lt. General William F. Cassidy, the Chief of the Army Corps of Engineers, at this hearing on the subject of Water Pollution Control and Abatement. My area of the Corps' geographic responsibility includes the United States' portions of the Great Lakes-St. Lawrence River System, together with the contiguous drainage areas thereto.

Problems of water pollution are not strangers in the Corps, nor in my own North Central Division. Several years ago, in response to Congressional authorization and provision of construction funds, and based upon an investigation by the St. Paul Engineer District, the action program for low water regulation of the Red River of the North was completed to ameliorate pollution problems. In the 1962 omnibus bill, the Oakley Reservoir on the Sangabon River, Illinois, was authorized by the Congress for Corps' construction, with provision for low flow augmentation for pollution abatement. Capacity to provide such required flows is presently being designed into the reservoir. In the recent 1965 omnibus bill, the Ames Reservoir on the Skunk River, Iowa, was authorized for Corps construction, with provision for low water flow pollution abatement. A vast majority of current Corps of Engineers investigations, both in North Central Division and Corps-wide, are being conducted in close cooperation with the FWPCA with a view toward providing adequate water supplies for municipal and industrial usage, together with augmented low water flows to reduce pollution

to an acceptable level after the fullest degree of treatment available to the riparian users of water in accordance with modern engineering standards.

In the area of particular interest to this hearing there are numerous survey reports or investigations in which the Corps of Engineers has a congressionally assigned responsibility or interest which deal with more effective water usage. Many of these reports include provision for pollution control and abatement as a multi-purpose usage of our water resources. Included among the Lake Erie-Lake Ontario basin streams under study are the Cuyahoga, Buffalo, Sandusky, and Genesee Rivers. Coordination or cooperation with other Federal, State, local and private water oriented agencies is either a requirement of law or an agency established regulation. In accordance with established congressional directives and Corps' policies, the most effective water and related land resource usage for all purposes is considered in all basin, sub-basin and action plan type of reports. In coordination with FWPCA, pollution control and abatement are treated as a prime water purpose in appropriate instances. For ready reference, the major engineering and economic study and investigation program of the Corps in this area is appended hereto as inclosure 1.

Treatment to abate pollution, including estimates of the costs and enforcement thereof, is primarily the province of the FWPCA of the Department of the Interior. The role of the Corps of Engineers in this field is to cooperate and coordinate to the fullest degree, and to engineer to the maximum practicable extent effective measures which are within the realm of practicable feasibility in those projects for which the Corps has primary responsibility.

Within the Corps' own establishments, aggressive steps have been taken to equip our floating plant and shore installations with modern and effective pollution treatment facilities.

In regard to the dumping of dredge spoil in the Great Lakes, the point has been made that this practice is not in consonance with pollution control objectives. The polluted material in the harbors, of course, does not originate with the Corps of Engineers. Our work consists of moving the material from one point in the lake, i.e. the harbor, to another—deep water. Thus we believe that this practice does not add to the pollution of the lake waters.

However, we enthusiastically support the need for positive and aggressive action to cure the pollution problem and are anxious to take any steps which are feasible and practical which will contribute to the solution. With this in mind we have made a study recently on the merits of placing the material in diked disposal areas as an alternative to dumping in the lake. This preliminary study considered 15 projects on Lake Erie and the results indicate that this will be an extremely costly procedure. The first cost of providing diked disposal areas with a ten year life was estimated to be about $110,000,000, which together with the added dredging costs would amount to an annual charge of about $16,000,000 over and above the cost of disposal by present methods. This figure is for selected sites on Lake Erie alone and for the first ten years. Lack of suitable space after the first ten years could conceivably increase this cost materially later. When all of the Lakes are considered we are dealing in tremendous additional costs. Also this is only a partial solution and has other unsatisfactory aspects. It will not take care of polluted matter in solution or suspension and the disposal sites will not be very attractive areas on the lake front.

The basic question then is whether this additional expenditure is warranted and whether to spend the money for this purpose or to apply it on eliminating pollution at the source. The economics of providing the diked disposal areas are now under consideration by the Federal Water Pollution Control Administration of the Department of the Interior.

Another action we are taking has to do with the control and removal of floating debris as opposed to the chemical and bacteriological pollution which one normally thinks of. We are preparing such a study for Cleveland Harbor. Such a study has been completed for Buffalo Harbor and Niagara River and is presently before the Bureau of the Budget for consideration.

The Corps of Engineers joins with other Federal, State and local agencies in concern over pollution problems such as in Lake Erie and will continue to seek means to preserve our water resources.

I greatly appreciate the opportunity to make this presentation to this Subcommittee.

Survey investigations involving consideration of water quality

WEST END OF LAKE ERIE AND LAKE ONTARIO

Location	Considered project	Status of study
Cattaraugus Creek, N.Y.	Basin study; however, local flood protection for village of Gowanda appears only practical solution.	Complete in fiscal year 1967.
Cayuga, Buffalo, and Cazenovia Creeks, N.Y.	Provision of multiple-purpose reservoir on Buffalo Creek for flood control and water supply, and reservoirs on Cayuga and Cazenovia Creeks for flood control are being considered.	Complete in fall of 1966.
Chittenango Creek, N.Y.	The study considers channel improvements and multiple-purpose reservoir for flood control and water supply.	Complete study in fall of 1966.
Tonawanda Creek Basin, N.Y.	Local flood protection project and multiple-purpose reservoir for recreation and water quality improvement is being considered.	Complete report in December 1966.
Genesee River, N.Y.	4 reservoirs—Belfast, Portageville, Angelica, and Stannard—are being studied in detail. The considered reservoirs may operate alone or as a system, and considered purpose includes low flow regulation.	Complete in 1967.
North Atlantic region comprehensive study.	Considers all water uses, including water quality.	Study underway.
Northeast water supply study	Oriented toward water supply, including quality.	Do.
State of New York program (sec. 214 of 1965 omnibus bill).	Considers all water uses where appropriate.	Corps participation authorized

Mr. MOSHER. I greatly appreciate it.

Colonel MEYER. Yes, sir. Mr. Chairman, we have covered in response to some of these questions, down to about the middle of page 5 of this prepared statement. If you have no objection, I'll pick up where we start talking about the question of utility of systems analysis, if this is agreeable with you, sir.

As I have indicated, we do have considerable expertise in the use of systems analysis and throughout the conceptual, definition, acquisition, operational, and ultimate disposal phase of military system programs, consideration is given to all of the elements of environmental pollution control. The great amount of effort exerted on air pollution problems associated with rocket propellant programs and, in particular, beryllium, is a specific case in point. It is possible that such techniques as we have followed can be applied to the problems of communities, and to those of a total industry. Unfortunately, what is often overlooked is that too heavy reliance on computer based technology cannot provide valid results without proper inputs as to the parameters involved. As in the case of goal setting, there is an evident need here for greater interdisciplinary efforts, for improved techniques, and for an expansion of knowledge.

As an outgrowth of our awareness of the complex problems of man-environmental relationships associated with military and space systems development, an appreciation has been developing of their possible application to civilian community problems. Some of the measures we have been developing for the microenvironment of space vehicles, and for the less restricted but nonetheless specialized environments of missile launch control centers and nuclear-powered submarines, may have some adaptive potential for the civilian environment.

The growing concentration of the American population into the restrictive confines of the major metropolitan areas makes it necessary

that there be a reappraisal of many current concepts and practices in regard to the logistics of waste management.

Over the years the traditional body of opinion in the sanitary engineering profession has been that individual waste treatment facilities such as septic tanks for homes or small complexes of buildings, were the least desirable method of approach. It well may be that an alteration in this philosophy is needed if the problem of water quantity as well as environmental quality is to be solved.

Even without the pollution problem, there is an increasing shortage of water to meet the demands arising from the crowding of approximately 70 percent of the total U.S. population into the 212 standard metropolitan areas. The lessons the Department of Defense and NASA are learning in the waste management and water recovery systems of spacecraft may provide useful techniques and concepts which can be applied to these problems.

It may be possible to develop means and systems for recycle of water within large high-rise buildings. As in all questions relating to environmental pollution, the cost or risk versus the expected benefits must be carefully assessed, and not solely in relation to the specifics of the pollution attribute.

As indicated in our remarks regarding "goal setting," there is a pressing need for a better approach to the establishment of the rationale by which both policy and implementation are developed. The Department of Defense interest in this matter is evident, since the objectives and requirements have a profound influence on the program and actions of the military departments, and upon their budgets. It seems that there is a pressing need for a reexamination of our concept of standards, and how they are derived. We are not only faced with some uncertainties regarding what constitutes adequate environmental quality, but also with the need for finding better means of ascertaining just which of several usages of the environment represent its highest and best utility to man.

Some of the apporaches taken in developing permissible exposure limits for industrial operations may be useful, provided they include a spectrum of conditions ranging from the minimum of sensory response to an emergency exposure. This infers a great deal more investigative effort in the whole area of human environmental stress relationships.

It should be emphasized that the research and development activities undertaken on environmental pollution by elements of the Department of Defense are related to the military requirements. While there may be a fallout of benefit to the general national effort, these investigations are not undertaken solely for the purpose of environmental pollution control. Because of the necessity for careful justification of programs and procedures, we have given considerable attention to the problems of scientific establishment of pollution control requirements. We have mentioned the activities undertaken in regard to rocket propellants, to shipboard waste, and specialized munition manufacturing operations.

In each of these there has been a need for investigation of the existing state of knowledge as to potentially harmful effects to the environment, on known means of detection and evaluation, and for possible preventive or control techniques. In each instance there has been a necessity for the most extensive coordination of effort with other Fed-

eral departments and agencies, and with civilian industry and local authorities. We have learned that in some instances the most rigid requirements of the early phases of a development program can be relaxed, whereas in other cases even more stringent steps must be taken.

One of the more serious situations in relation to the Defense Department's capability to deal with questions of environmental pollution is that relating to manpower. If we are going to be able accurately to define problems and develop effective yet economical solutions thereto, it is absolutely essential that we have available highly capable experts in the various disciplines necessary for a complete program. This matter affects not only the Department of Defense but to a large measure, other Federal agencies, and the national capability as well.

Lastly, sir, based on our experiences, there are three areas in which definitive action can be undertaken now, which provide for evolution based on advancing knowledge and changed circumstances. These are:

First, a more systematic effort to marshal our current knowledge. This involves developing a better appreciation of what we know, what we don't know, and to what degree our current concepts have a valid base.

Second, undertake the solution of identifiable problems, in a practical and economical sense. This, sir, on the side, infers a better program definition and facing.

Third, discern and define the problems of the future, and initiate those actions necessary to achieve their solution, in phase with the emergence of the problem.

Insofar as our responsibilities are concerned, the Department of Defense will continue to give this matter major attention.

Sir, I am ready for any further questions that you or the committee have.

Mr. DADDARIO. Colonel, would you go into this manpower problem? What is the nature of it? Is it a different problem in the military? Is it a matter of training more people or is it simply a matter of shifting around those who are assigned to other tasks?

Colonel MEYER. Sir, it is basically a problem of procurement of new people as well as a problem of retaining the skilled people which we have. We have identified within the Defense Establishment the people who are with us who have the skills and in the main they are being used in this effort in one way or another. Our principal problem relates to the larger issue of training programs in the civilian educational area of the development of the type of educational patterns to fit what is changing from what is a traditional sanitary engineering area of the past and then once having done this to also provide for something which is a problem affecting the entire Military Establishment of means of attracting and retaining these people in the military service.

Now, in my responsibility as Chief of the Biomedical Sciences Corps of the Air Force, I have cognizance over all the allied health professions and what I reflect here is what I know to be the case in the other services. Eighty percent of our people have less than 10 years service and yet we have had these types of people in the system for many many years. This reflects a serious problem as far as retaining these people are concerned. It is of interest to your committee also because it has to do with the general problem of management of such facilities as

the Naval Aeromedical Research activities, the USAF Aerospace Medicine Division and so on.

In addition to that problem, of course, is the one that there has to be developed some specialized educational patterns.

We have done a great deal of this, I might add, in the military with working with civilian educational institutions to develop tailored patterns, but this is a serious problem.

The last information that I had in the sanitary engineering area alone and this is not the only area, we are talking about biologists, all sorts of social scientists, there are a lot of social sciences in this, legal people and so on, but in the sanitary engineering area alone the last figures by the Department of Labor showed 4,900 of these people identified in the United States and only a hundred in training, and of this 4,900 if the figures I recollect are correct, about 65 percent are age 40 or over.

We are developing national programs in the field of environmental pollution in all attributes, and yet we have got to have professionals, specialists who are really capable of analyzing and developing and approaching these problems.

Mr. DADDARIO. Mr. Waggonner?

Mr. WAGGONNER. Mr. Chairman, it would appear to me that what the Colonel is saying about the manpower situation is that the development of technology will have to wait until we get the personnel. It seems to be a major consideration here. I think this is extremely important.

It is commendable that the DOD recognize that pollution abatement is not a simple matter and that it involves economic, social, and political considerations. I found quite interesting a recommendation that it might be possible to recycle water within large high-rise buildings. If it is possible for large high-rise buildings, wouldn't it also be feasible within the confines of a specific military installation for example?

Colonel MEYER. This is possible, Mr. Waggonner, and this is one of the areas which as we approach these, getting the basic, immediate problems identified within the Defense Department which we are devoting a lot of attention to, that certainly research and development actions as recommended by the President's Science Advisory Committee, including pilot demonstrations very well might be undertaken. It is one we have to gain with no excess cost to the Military Establishment of undertaking this.

Mr. WAGGONNER. Several times you referred to beryllium as a rocket propellant. You seemed to place a great deal of emphasis on beryllium. Is this a matter of special concern to the Department of Defense, the Air Force, or the Public Health Service?

Have you people had some problems with beryllium?

Have you done anything about it yourself?

Are you working with the Public Health Service to do anything about it?

Colonel MEYER. Mr. Waggonner, the problem of beryllium is one that has attracted a lot of attention in the last several months. Perhaps the thread of interest reflected in this presentation is a reflection of the concern which has been evidenced by some authorities regarding the use of beryllium as a rocket propellant or as an additive in the rocket propellant. That is the first thing we are talking about, additions of small quantities of this material.

It of course is part of our national military and space program, the development of improved propellants, and we have some people with me who are quite conversant with the propellant program. As you will recollect, beryllium is a very dangerous material. There is no question about this. In recognition of the fact that we were proposing to test and develop propellants in which this material would be used as an additive, we earlier recognized well over 11 years ago the fact that we didn't know all we ought to know about this subject and have undertaken a rather extensive research program on both the dispersion of the material in the atmosphere following propellant testing, the toxicology of the material, and all of the problems associated with detection and evaluation of the presehce of the material in the environment.

Our comments do reflect a sincere concern of a specialized problem which also might be typical of any industry which is undertaking to manufacture, produce or handle a material which is a potential toxicant or has potential environmental pollution characteristics.

Now, specifically to answer the question, "Are we working with the U.S. Public Health Service?" We are indeed very closely working with the U.S. Public Health Service on this matter to arrive at an agreed-upon approach to the definition of acceptable environmental quality standards for the presence of a material which is needed for the national defense but which possesses certain attributes which might make it harmful if present in too large a quantity.

This is typical of this risk versus benefit and application of technology as to what you know now and what you need for the future.

Mr. WAGGONNER. That leads me to my last question. The chairman of this subcommittee, who is one of the most capable men I have ever known in my life, seized immediately upon your stress of the word "practicable" earlier during your prepared statement.

I share some of his concern about your use of the word practicable. I had the feeling that you were trying to relate cost to benefit when you used the word practicable. Specifically what does the Air Force do in pollution abatement as they relate cost to benefit?

Where do they draw that line of practicality?

Colonel MEYER. I think that I will have to answer this in two parts. In the first instance when we are talking about, and if I could address myself to the question of practicality, there are several attributes of this problem. It would be completely feasible to pass legislation or to establish regulations which said there shall be zero emissions of a certain material into the environment. I mean, this just takes the administrative authorities' willingness to say that this is what is desired. This may be without the availability of means of reducing the discharge to zero. Or, again, coming into the cost versus benefit, that the costs would be so great in return for the benefits of not having zero discharge, the little bit of appreciation—and I have a chart here which has been used in one previous hearing which, if the chairman would permit, I know time is running out, I would be happy to just show it, it shows the cost-versus-benefit problem, if it is permissible, sir.

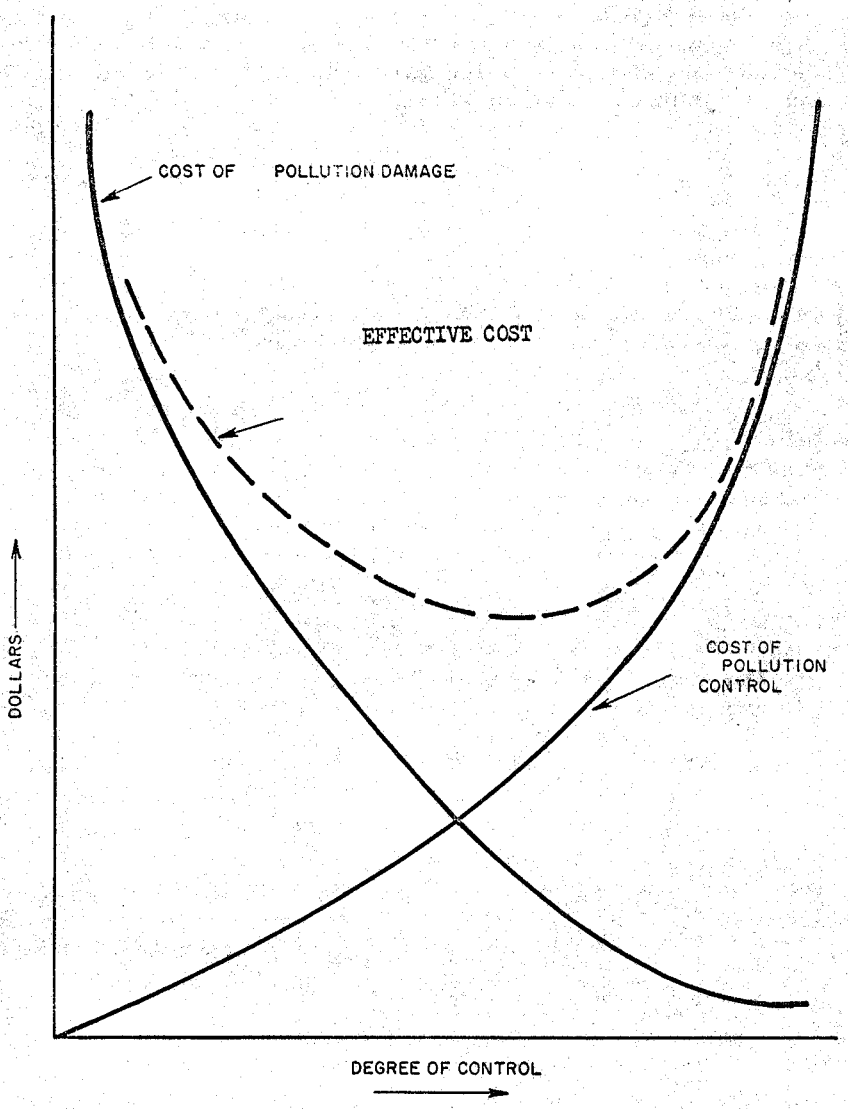
While he's bringing this up, the other aspect of the practical side to this is, can you measure the environment? You know this business of requirements means that you have got to have some way to analyze the situation if you are going to enforce something, Mr. Chairman, and my eminent friend, Congressman Waggonner, you have got to be able to

find out whether you have zero, and maybe the means available of measuring this material in the environment won't let you get down to determining the absolute absence of the material.

Now, I have used this as an extreme example, but it relates to the test of practicality. First, of course, is do you have the engineering and the financial means to achieve the end desire?

Second, do you have some way of measuring to determine whether you have gotten there? And, of course, third, which gets into this cost-versus-benefit concept—which this one chart really shows, sir—whether there is, indeed, a cost of damage; and this applies to a lot of other things.

For the record, the following copy of this chart is furnished.



Mr. DADDARIO. I think it is in your statement.

Colonel MEYER. Yes. If this one isn't, we certainly will see that there is one.

But, when there is a cost of damage, it may be dollar cost to the community. It may be loss of efficiency of people. It may be loss of marketability of crops. There are a whole lot of things in this environmental pollution thing just besides air and water.

At some point you can find that the cost of controls as you apply controls, that you are reducing the cost of the damage. And, as long as the cost of the control is less than the cost of enduring it—and I'm not just talking about a dollar cost—then you have an effective cost which is reasonable, but you may go beyond a point that you simply cannot, by applying incremental controls to, say, zero, fail to have an excess of expenditures over that which would have existed for damage alone. It may come back to the point that you are spending just as much as if you were willing to endure this damage.

Now, Mr. Chairman and Congressman Waggonner, what I am not saying here is that we advocate pollution. Somebody could infer that from this. But, we are saying that you have to determine these questions in arriving at what you are going to do.

Mr. WAGGONNER. What you are saying, in effect, is that we can reduce air pollution from some industrial plant which destroys the paint on the homes in the neighborhood if the cost of reducing the air pollution does not exceed the cost of repainting those homes at regular intervals. This would be a cost-benefit ratio that would be acceptable and practical.

Colonel MEYER. Provided there are not also demonstrable hazards on health. This is a complex problem. You have got to take into account the fact that the loss of human efficiency resulting from the presence of these environmental pollutants also has to be taken into account. And, the cost——

Mr. WAGGONNER. That's all, Mr. Chairman.

Mr. DADDARIO. Mr. Waggonner raises a very good point, however. If you don't have an opportunity to test our new facilities to develop new criteria, you are going to be using old techniques, and you will never change that graph in any radical way.

Colonel MEYER. That is correct, sir.

Mr. DADDARIO. And that's what you are pointing to, Mr. Waggonner.

Mr. WAGGONNER. Yes.

Mr. DADDARIO. Mr. Vivian?

Mr. VIVIAN. I have a brief request. I would like to have submitted for the record, a breakdown of the amount of money spent and number of persons engaged in pollution control in the Department of Defense.

Colonel MEYER. Very well, we will get that to you.

(The information requested is as follows:)

STATEMENT ON DOD POLLUTION ABATEMENT PERSONNEL AND ESTIMATED COST OF ABATEMENT OPERATIONS

It is difficult to provide detailed information on the total personnel involved in pollution abatement in the Military Departments. Similar problems exist with regard to the total annual expenditure funds for pollution abatement operations. Due to the nature of the military organizational structure, considerable numbers

of personnel are directly involved in environmental pollution detection and abatement activity for part of the time incident to their other military functions and duties. As an example, although there are numbers of Medical Service and Civil Engineering specialists working full time in environmental pollution work, many environmental engineering personnel (such as sanitary engineers and industrial hygienists of the U.S. Army, industrial hygienists and sanitarians of the U.S. Navy, and bioenvironmental engineers, USAF) are broadly trained and because of the scarcity of such personnel, work on all aspects of the environmental health problem not just restricting their work to environmental pollution abatement. The nature of their combined engineering and health educations fit them for this type of activity and to accept the responsibility of supervising and managing technicians. Similarly in the civil engineering functions, while there are some personnel exclusively concerned with design, operation, and maintenance of pollution abatement works, a considerable number are involved in broader responsibilities. With increasing emphasis on air, water, and solid wastes disposal problems, a greater degree of full time specialized effort and activity will be necessary. All of the military departments have currently pending program change proposals for the first incremental increases to meet these new responsibilities. Information on the current full time equivalence of DOD environmental pollution control personnel are shown in Table I.

TABLE I.—*Average man-years—DOD environmental pollution control*[1]

	U.S. Army	U.S. Navy	U.S. Air Force	Total military departments
Medical service:				
Professional	23	30	82	135
Technicians	100	20	100	220
Civil engineering	27	12	10	49
Total	150	62	192	404

[1] Does not include plant operators, or miscellaneous support personnel, whose salary costs are included in table II.

The majority of the professional personnel of the three military Medical Services are commissioned officers, whereas the majority of the professional personnel for the Civil Engineering functions are civil servants. This reflects the traditional requirement of the military medical departments for personnel who are competent in the field of environmental health and who can be utilized world wide in a military situation. The relatively larger number of such individuals currently utilized by the U.S. Air Force reflects environmental pollution and control programs associated with the development and deployment of strategic missiles in the operation of the three regional environmental health laboratories.

In the case of cost of pollution abatement, fairly precise information is available regarding waste water disposal operations, on the general cost of environmental surveillance and as to construction which has been approved for waste water works. With regard to costs associated with systems development, toxicology, and some of the research and development programs, information is available although some of these costs are not directly identified with environmental pollution. In the case of air pollution, control procedures associated with industrial operation and for power plants, no specific identification has generally been made as to the cost since these items are included as part of an overall building or facility design. Greater attention will be paid to these items as a result of the recent Executive Order on air pollution and the proposed implementing instructions regarding identification of problems and development of cost estimates for correction. Similar estimates will be developed with regard to cost of disposal of solid wastes which at the present time, due to the variation in disposal procedures and in internal identification of costs therefore this subject is not included. A summary of typical expenditures for the most recent fiscal year is provided in Table II. The cost reflected therein should be expected to increase in view of the previously discussed need for additional personnel and as a reflection of the five "Phased and Orderly Plans" for installation of waste water treatment facilities now being studied by the Bureau of the Budget and as a result of the plan for air pollution which will be submitted in 1967. The

current level of expenditure of approximately 31 million dollars will probably increase by as much as 30 to 40% in the next several years and possibly could exceed that figure.

TABLE II.—*Estimated costs (million dollars) DOD[1] environmental pollution control, typical fiscal year*

	U.S. Army	U.S. Navy	U.S. Air Force	Total military departments
Medical service laboratories and surveillance	1.2	0.1	0.55	1.76
Civil engineer professors salaries	.33	.13	.13	.59
Operation and maintenance of works (including operator salaries)	5.25	5.7	5.8	16.75
Purchase of sewer services	.5	.7	.5	1.7
Estimated fiscal year military construction project	1.5	1.1	3.2	5.7
Total	8.75	7.63	10.25	26.4
Research, development and test				4.5
Total				30.9

[1] Exclusive of industrial process ventilation and similar operations.

Mr. DADDARIO. Thank you very much, Colonel. We certainly appreciate it.

Our third witness for today was to be Mr. Bertram C. Raynes, vice president for applied research, Rand Development Corp.

He has driven in from Cleveland. We have requested that he appear before us tomorrow since we only have one witness scheduled. He has consented to stay and we certainly appreciate it. We will adjourn these meetings at this time until 10 o'clock tomorrow morning when we will hear from Mr. Raynes.

BIOGRAPHICAL STATEMENT OF COL. ALVIN F. MEYER, JR.

Colonel Meyer is Chief of the Biomedical Sciences Corps, USAF, and Chairman of the Department of Defense Environmental Pollution Control Committee. He was born in Shreveport, Louisiana, in 1920, received his engineering degree from the Virginia Military Institute, Lexington, Virginia, in 1941, and is a graduate of the resident course of the Industrial College of the Armed Forces, June 1962. Colonel Meyer has received advanced education and training in bioenvironmental engineering. He has held increasingly responsible positions in the USAF Medical Service, including duty as Chief Engineer in the Office of the Surgeons, Air Materiel Command and Strategic Air Command. He is a diplomate of the American Board of Environmental Engineers, American Board of Industrial Hygiene, and is an associate fellow of the Aerospace Medical Association. He has served on numerous national professional society and Federal committees. Colonel Meyer is the author of a large number of publications in the field of environmental pollution.

PREPARED STATEMENT

DEPARTMENT OF DEFENSE PRESENTATION

VIEWS ON THE ADEQUACY OF TECHNOLOGY FOR POLLUTION ABATEMENT

DEPARTMENT OF DEFENSE INTEREST

The Department of Defense and its subordinate activities are charged with responsibilities to provide for environmental pollution abatement and to demonstrate leadership. The Federal Water Pollution Control Act and the Clean

Air Act, and Executive Orders, provide for a wide degree of involvement of the Department of Defense in minimizing the effects of its operations that may produce pollution of the environment.

The concern of the military departments and activities for pollution control, however, is not a new development. As has been pointed out by Departmental representatives in appearances before such committees of the Congress as the Senate Special Subcommittee on Air and Water Pollution and the House Committee on Interstate and Foreign Commerce, there is a long history of military leadership in the fields of environmental sanitation and military preventive medicine. As this Committee is well aware, military leaders have had to take into account the effects of disease on their combat capability. It does seem appropriate to point out that as there developed an increasing awareness of the relationship between environment and disease in the late 19th and early 20th centuries, military medical and engineering departments were in the forefront of application to practical problems. During and since World War II the increasingly complex technology involved in military systems has resulted in a vastly expanded activity in relation to both protection of our own personnel and the avoidance of harm to neighboring civilian communities.

There are a number of serious problems affecting the Department of Defense arising from the need for continuing these activities, accelerating their pace to provide for Federal leadership, and at the same time ensure that our budgetary programs remain within manageable limits. All of the issues raised for the consideration of the Congress in the excellent report of the Research Management Advisory Panel are germane to the overriding consideration of the development of improved national planning for long term solutions to the environmental quality problem. This is no easy task. It involves a definite need for the establishment of better communications and more formalized areas in the Federal establishment for the coordination of energy and effort. In Section II of "The Adequacy of Technology for Pollution Abatement" there are comments regarding the comprehensive and complex nature of environmental pollution. The interrelationship of the problem of domestic food waste to air pollution, soil pollution and water pollution is one which the Department of Defense well recognizes. The existence of this interrelationship highlights the importance of a coordinated planning effort. It is essential that the various separate interests somehow be brought to bear upon fundamental problems. In this manner we should achieve the result of better technical and economical programs.

The following comments relate to some of the issues raised in the Report of the Research Management Advisory Panel, "The Adequacy of Technology for Pollution Abatement." These items are not necessarily discussed under the same heading as included in the Report, and have instead been included in a joint discussion with other subjects where this has been more appropriate to Department of Defense activities.

Goal Setting and Research Strategy

Probably the most important problem insofar as the Department of Defense is concerned is the need for better understanding of just what we are trying to accomplish in relation to environmental pollution abatement. There are a wide variety of different requirements and interests which influence local, State, and Federal program definitions. It is not our desire to undertake an extensive discussion of the problems of definition of environmental pollution. Our experiences indicate that there is a growing need for greater attention to the questions of environmental quality requirements. The definition of environmental pollution established by the President's Science Advisory Committee is a useful statement of a general problem. Standing alone, however, this does not constitute a national goal. It defines the problem. Perhaps more realistically, it states what the problem is about. From the practical viewpoint of those concerned with both near and long term program planning, it is evident that there will be greater attention given to better definition of environmental quality and a greater recognition as to just what level of environmental status is appropriate for the various situations and conditions affecting the problem.

The task of goal setting involves the issue of human health effects as being the measure of environmental quality. While there may be many differing interests which must be taken into account, the response of humans still must be the principal measure in ecological management. The situation is not really

different from that which has concerned public health officials over the years. When decisions must be made as to allocation of funds and resources including the personnel element, some rank ordering of the projects and programs must be made.

Environmental Pollution abatement ought not to be considered as an end unto itself. There are other elements of ecology which are related to the larger needs for resource utilization. In the long range view, the degree of environmental quality established as an objective depends upon the understanding and desires of the general public. In the case of those situations where there is an obvious cause and effect relationship upon health, or some desirable attribute of the environment, these desires may be readily translated into either regulation or statute, or be achieved through voluntary action. In other instances, this may be far more difficult. In some situations, because of a lack of full understanding, the objectives and the rules by which they are applied may be of such a nature as to be economically unreasonable. Those who are truly knowledgeable about ecology and the specialized considerations therein have an increasing responsibility to ensure that there is an interchange of information and knowledge with their colleagues in the various disciplines and to the public. Doctor Barry Commonner's remarks several years ago on another but related subject are pertinent to this:

"What appears to trouble the public is not that political opponents disagree, but that the opinions of scientists have been marshalled on both sides of the debate. A natural result has been confusion on the part of scientists, statesmen, writers and the public at large. Scientists as students and interpreters of nature can explain to the public what consequences may result from a given situation. They should not attempt to form public opinion on wisdom of enduring whatever these consequences are. . . . Moral judgment is not the exclusive perogrative of scientists, and they cannot claim any more competence than those of equally informed citizens on such values."

The Department of Defense is aware of the need for making available information derived as part of its investigative efforts. Although sometimes the requirements of military security necessitate prudence and care, action is taken to provide for an interchange of professional data with civilian colleagues; and through our information program.

Industrial Research

Enforcement procedures

More specific comments on the question of enforcement legislation and regulations are contained in the remarks under "The Scientific Basis for Pollution Policy." Considerable attention is being given, in accordance with Executive Orders, to the question as to what extent the current requirements affecting the Federal establishments for pollution abatement can be levied upon industrial contractors. It has been our experience that many defense industries are as concerned about the problems of pollution abatement arising from specialized industrial activities as are the military departments. It is worthwhile to point out that in a number of instances such as in the propellant manufacturing program, contract provisions have included the necessity for compliance with appropriate environmental pollution abatement procedures and for the development of appropriate technology where there were known gaps in the state of knowledge.

Any regulatory program is necessarily dependent upon some means of measure of compliance, and this in turn depends upon techniques for surveillance. Concurrent with development of industrial processes, and waste control equipments, there should be effort to provide the necessary detection and warning devices. Standardization of collection and analytical techniques has been found to be necessary, if major differences between individual agencies and industries are not to result. In the case of the assessment of ozone production associated with certain military test operations in the Los Angeles area, a major effort was undertaken to ensure that the methodology used by the defense contractor involved was compatible with the regulations of the Air Pollution Control authority, and with the technology utilized by that Department in their own measurements.

Industry and public relations problems

The Department of Defense has had some degree of experience in working with its contractors in certain aspects of environmental pollution problems. In particular, we have had some experiences in the West Coast area on the problems

of air pollution and missile and rocket propellant testing. It is true that in the initial phases there has been some reluctance on the part of certain industries to enter into negotiations with local or State pollution abatement atuhorities to ensure that the programs developed under Department of Defense requirements were acceptable to the local or State authority. By patient, careful and conscientious efforts to ensure a better understanding of these requirements on both sides, in the main, suitable and amicable arrangements have been effected. This requires determined efforts and intelligent leadership on the part of all concerned. It should be remembered that many times the industry knows more about the problem than those in the legislative and enforcement authority. This is particularly true when dealing with new processes or chemicals such as is often the case with Defense associated industry. Because of Department of Defense policies and requirements that environmental pollution control procedures be incorporated into these developmental and production programs, it becomes incumbent upon us to ensure that consistent with the requirements of security, appropriate information is translated to the responsible abatement authorities. Our experiences in dealing with such material as unsymmetrical dimethyl hydrazine, nitrogen tetroxide and fluorine indicate that such cooperative actions can be taken.

The recycle concept versus consumption pattern

In a number of military situations, attention has had to be given to the questions of how to provide for what is in effect a closed ecological system. Members of this committee are obviously aware of the need for the recycle in recovery of essential elements from waste associated with the space program. Limitations on power, weight and cubage, as well as the unique characteristics of the space environment make it necessary to provide for water recovery from human wastes for human use and for long term space operations. Consideration of the interrelationship in the waste cycle for regeneration of oxygen and for production of food, in the completely closed ecological system, is not so much waste abatement as resource management.

In the semi-closed ecological environment and ecological system associated with certain other military systems, such as the nuclear powered submarine and underground missile launch control centers and underground command posts which may have to become for periods of time closed systems, similar if not quite as extreme considerations and provisions must be made. While there may not be a direct translation from these unique environmental situations to those of urban communities, it does appear that there are some lessons which can be learned and that there are possibilities within today's technology and engineering capabilities which deserve further investigation. One of these to which some initial thought has been given relates to the possibility of water conservation and reuse associated with high-rise office buildings and living accommodations. While no formal proposals within the military establishment for such projects have yet been developed, some tentative evaluations in this area are being considered. In areas of water shortage, such as in the East Coast multi-metropolitan areas, the problem is not only one of waste abatement and pollution control but also of water quantity. If suitable waste treatment methods can be devised and the necessary sociological accommodation to the utilization of recycled waters can be achieved, the twofold problem of relief of water demand and avoidance of pollution of the receiving streams might well be achieved.

In this connection the cost and benefit factors must be carefully assessed. It may be difficult, if not impossible within existing structures to make the necessary alterations and operational costs of equipment may be of such an order that specialized tax or other benefits may have to be provided to encourage adoption of such measures.

In the field of solid wastes, to a large extent the military departments now do indeed practice a recycle type of activity. The economic value of material no longer useful for the purpose intended has been recognized. Virtually every military installation has a classification, salvage and reclamation yard. Materials which are recognized as having a utility in the civilian economy are offered for sale. Those which have a potential further military utility as a repair, maintenance or small commodity item are reclaimed and processed and only those which can neither be utilized in this manner nor sold for scrap ultimately are disposed of. The volume of the latter, of course, in the Department of Defense is not insignificant. Without this effort, the solid waste disposal problems would be almost insurmountable.

The sanitary land fill system which has long been a part of military as well as municipal waste disposal methods is in itself a reclamation activity in that the fundamental philosophy is of using wastes to fill what would be normally unusable land. Unfortunately, both misuse of the system by failing to operate it properly or to combine it with the so called burn and cover method, and the lack of available suitable land sites in the vicinity of metropolitan and large military complexes has tended to bring this system into disfavor.

In a consumption economy it may be easier to dispose of waste materials even though having some utility or reuse value, rather than to experience the costs of collection, transportation, assembly and processing. In some instances, military departments have found it difficult to dispose of certain waste materials in spite of our classification, reclamation and salvage operations. Materials having relatively immediate usefulness may not find a ready market. An example is the case of waste red fuming nitric acid, utilized in the early stages of the missile propellant program. This material might be of use in fertilizer manufacturing, in metal processing, and in a number of other industrial operations. Unfortunately, the cost of removal of such hazardous materials and the additional precautions necessary in its transportation and handling are such that not only could the material not be sold, but it could not be given away. As a result, procedures for disposal in a safe and satisfactory manner had to be developed. It is anticipated that similar problems may result during the phase-out of missile systems utilizing the storable propellants such as unsymmetrical dimethyl hydrazine.

There have been some notable achievements in the development of reusable packages and containers for military material and equipment. The so-called Conex packages for shipment of large items have already found an adaptation to civilian use as containerized packages which are placed on trucks, railroad cars, ships and aircraft. These reusable packages have produced reduction in formerly generated packing and crating waste material.

The improved handling methods have also resulted in better efficiency of operation. The problems of solid waste in the military establishment are of major concern and will be given increasing attention. As has been observed by some, increasing demand for petro chemicals makes petroleum of increasing importance as a raw material rather than as a source of energy. The possible use of the thermal potential in solid waste has been under investigation by some authorities. The interest in the Department of Defense in this is somewhat incidental (since we feel that the primary responsibility rests in the civilian sector). These are obvious implications as to conservation of propulsion fuels and the interrelationship of the industrial economy with the mobilization base. The President's Science Advisory Committee recommended that the military departments give consideration to possible pilot studies in this area. It is contemplated that this matter will be given increasing attention as we achieve success in our current high priority endeavors to comply with various directives and legislation relating to development of programs and plans for water pollution and air pollution.

Determination of costs of disposal in initial planning

There is some discussion later in this report regarding the systems analysis and systems engineering techniques which have been used to provide for environmental pollution controls in military system development. This approach has resulted in an early determination of pollution control requirements and an assessment of research needed to develop new procedures where existing state-of-the-art technology was not adequate. In the case of the Titan II system, it became evident quite early that there was a need for investigation as to the proper means of disposal of waste unsymmetrical dimethyl hydrazine. Concurrent with the propellant testing program, studies were conducted by the U.S. Air Force regional environmental health laboratory at Kelly AFB, Texas to determine based on the then available information what possible means of handling this problem were available, and what practical designs could be evolved. After the classic bench top and pilot plant investigation, a number of alternatives were proposed and a suitable design selected.

Because the military departments do operate within strict budgetary and personnel allocations, most careful attention is being given and has been given to ensure that control measures or proposals for modification or improvement of the environment are consistent with the requirements of economy and necessity. The approaches which are taken on this are in general the same in the

three departments with some variation. If these procedures are followed, it ought to be possible to ascertain at an early point in any community or environmental or industrial activity the anticipated requirements for maintenance of environmental control through pollution abatement. These involve the following:

a. The most economical approach is the early involvement of the pollution abatement specialists in the planning and conceptual phases.

b. There should be evaluation of the process, operation, or situation with a view to substituting in the case of industrial operations less dangerous materials, or the use of waste materials in a recycle basis as a raw material or part of the process.

c. The design of process controls to minimize the production of wastes. A classic example in this regard is the control of trichloride ethylene vapors through proper use of a degreaser and the reduction of pullout of plating solutions by proper movement of the plated objects out of the plating tank.

d. The design of the appropriate waste control or environmental pollution prevention devices.

In arriving at ultimate recommendations, it is obviously necessary that there be thorough information on all aspects of the problem, that all possible means of achieving the desired result must be undertaken and the most suitable selected. Then there must be examination and check of the efficacy of the final product. The military departments and agencies operate a large industrial complex. The effort to control pollution at the source through application of the foregoing procedures results in a lessened cost insofar as abatement works and techniques are concerned. There are no clearly defined means of discerning which requires the most attention. Rather, the cost versus benefit approach must be taken here as in the case of the entire pollution abatement question.

Federal Research and Development Program

Short-term solutions vs. long-range remedies

Department of Defense Environmental Pollution Control Programs have been planned with a view toward long-range requirements. Those research, development, test and evaluation activities conducted under the auspices of the military departments have ranged, however, from consideration of problems having an immediate implication and demanding an urgent solution, to those providing information useful in the approach to the problems extending over a period of years. Several examples should be cited to provide better appreciation of this spectrum of interest and action.

The case of investigations on air pollution from diesel motors on tanks and their effect on both crews and nearby personnel, discussed in the testimony before the Senate Special Subcommittee on Air and Water Pollution in 1964, is typical of those projects undertaken to deal with a more urgent situation. As is the case with many other investigations of this sort, there is developed information which may be useful in attacking the long-range problems.

Another typical case of an investigation conducted on a specific near-term situation is the extensive studies conducted for the Department of the Air Force on the problems associated with a suitable treatment method for plating plant wastes at Patrick Air Force Base, Cape Kennedy, Florida. Here again, although directed toward a single problem, the information obtained has been useful in developing design criteria and guidance for similar projects.

The nature of military development programs generally involves the development of hardware end items. While some research is conducted to ascertain principles, the majority of our efforts in relation to environmental pollution have an ultimate end product as a goal. Studies conducted under the auspices of the Army Medical Research and Development Command on such subjects as water disinfection have as their objectives the determination of critical parameters which may be utilized for definitive engineering design criteria.

Another evidence of our appreciation of the need for long-range considerations are the programs concerned with closed ecological systems. The Air Force and the Navy have have engaged in extensive research as previously indicated in this testimony, on this subject. The Navy's studies with regard to the nuclear submarine program contribute much in the way of knowledge as to permissible concentrations of atmospheric contaminants. These, along with investigations conducted by the Air Force on space cabin problems, provide useful points in

the broad spectrum of information necessary for the development of environmental quality criteria.

The research and development programs of the Department of Defense which have environmental pollution implications are developed in accordance with our systems analyses and our recognition of problems having particular importance to military capability and military installation operation. A conscious effort is being made to extract such information as it may be of use in the larger national problems. Increased attention, as recommended in the President's Science Advisory Council's Report "Restoring the Quality of our Environment," will be given to the possibility of undertaking those pollution abatement investigations which can properly be conducted under Defense auspices. It is recognized that as indicated in the President's Science Advisory Council's Report, military bases do contain a mix of waste disposal problems characteristic of large population centers, and that they do afford an opportunity for examination of possible innovations under controlled conditions. Any such projects, however, obviously must be conducted in such a manner as not significantly to increase the cost of the military establishment nor to produce substantial interference with base missions and activities.

Prospects for application of military space research and development technology

In this report there have already been some comments regarding possible application of work done in military and space research and development programs. An extensive evaluation has been accomplished of human adaptation and accommodation requirements. The more important potentials for application of the concepts utilized in these programs are those relating to systems analysis and systems engineering. The military departments have developed considerable experience in this regard. Departmental policies as outlined in the referenced DOD Directive 5100.50 make it necessary that at the earliest point in system development, cognizance be given to the potential problems of environmental pollution and there shall be necessary provisions therefore in the entire program. In effect, the systems analysis effort results in the treating of the environmental pollution problem as a subelement of the overall system. It will be recollected that systems program development involves three general time phases. These are: the conceptual, the acquisition, and the operational. A summary of the considerations which must be examined in addressing the problems of the man-environment relationship is furnished in Table I.

TABLE I.—STEPS IN ENVIRONMENTAL POLLUTION SYSTEMS DEVELOPMENT

1. Determination of potential hazards associated with research, development, and pilot plant operations, and establishment of precautions for employees and neighbors.
2. Participation in operational site selection surveys, so as to take into account health requirements of system personnel; and also possible dangers to adjacent civilian communities.
3. Establishment of criteria for health protection and health promotion of system operators and maintainers, and advice on design of facilities, equipment, and procedures to meet the criteria.
4. Analyze and recommend regarding potential community environmental (air, water, land, livestock, etc.) contamination.
5. Provide for environmental health and medical aspects of accident or disaster situations.
6. Prepare necessary biomedical and health education documents and publications.
7. Participate in systems test programs, to assure adequacy of criteria and health considerations to meet same.
8. Continually maintain required environmental medical surveillance after the system has become operational.

We are concerned with both the system-worker interface and the system-community interface. This technique provides a means whereby at the outset of planning, the need for further research can be established and an approximation of the anticipated costs of pollution abatement and attendant environmental surveillance can be developed. These procedures involve a highly integrated and multi-discipline effort. We are aware of the fact that some industrial organizations follow similar procedures in their new plant developments.

The approach to inclusion of environmental pollution considerations in an actual systems development program can be cited as an example of the use

of this technique. In the hearings of the Senate Subcommittee on Air and Water Pollution on missile and rocket propellants a number of details relating to the Titan II system were described. The following overview of the actual measures undertaken as part of this system engineering effort will be more useful when the schematic illustrations in Figures 1 and 2 are reviewed.

During the conceptual phases of this system, authorities concerned with the operational program, in accordance with departmental regulations, presented information to the military medical services regarding the fuels proposed with a request that information be provided regarding possible effects on operator personnel and also any other harmful characteristics which should be considered. A review was made of the available toxicological and environmental health data in the light of the proposed deployment of the system. An analysis was made of the problems of production, installation and checkout and attendant maintenance problems. Based upon these tentative evaluations there were incorporated into the "system development plan" requirements for research on toxicology, on environmental detection devices, on environmental controls, and on occupational and environmental medical needs.

Since the initial information indicated that there was a substantial body of knowledge regarding one of the propellants, nitrogen tetroxide, but relatively less regarding the other, unsymmetrical dimethyl hydrazine, preliminary precautionary plans were developed. These pertained to work conducted in the contractor's facilities and those on defense bases. Interim technical orders and precautionary instructions were issued. The hazards research, including that relating to both air and water pollution, was implemented. Based on initial results, some modification of the initial precautionary procedures was possible.

Since the possibility of catastrophic accident at an operational facility had to be taken into account and a need for providing for potential pollution control, these elements were included in the site surveys to determine where the facilities should be located. Assumptions had to be made as to the degree of effectiveness which could be provided in the pollution control system. It should be noted that

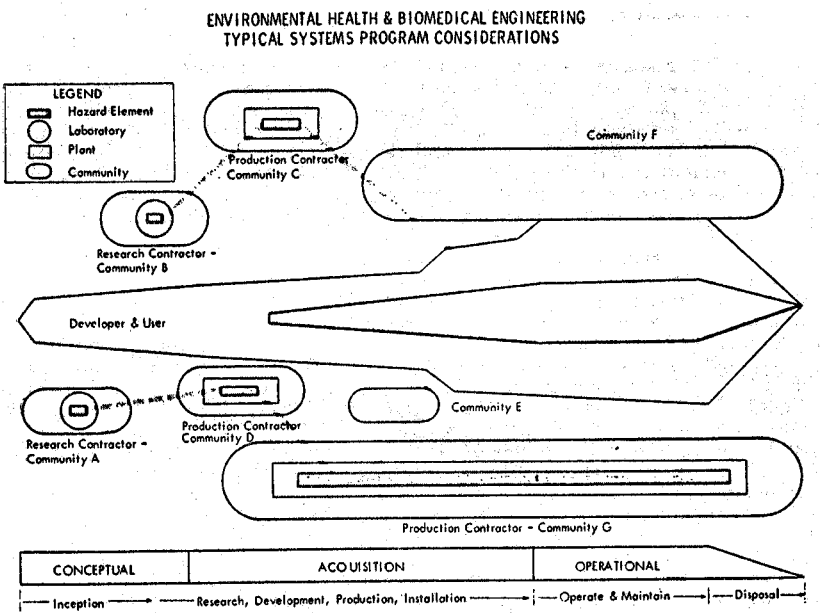


FIGURE 1. Environmental health and biomedical engineering; typical systems program considerations. In systems programs there are generally three time phases: (1) conceptual, (2) acquisition, and (3) operational. The effect of potential hazards must be considered as the summation of effects of the researcher, the builder, the production worker, and the user. Concurrently, consideration must be given to effect on the health of the community adjacent to the plant or site, or through which materials and components must be transported.

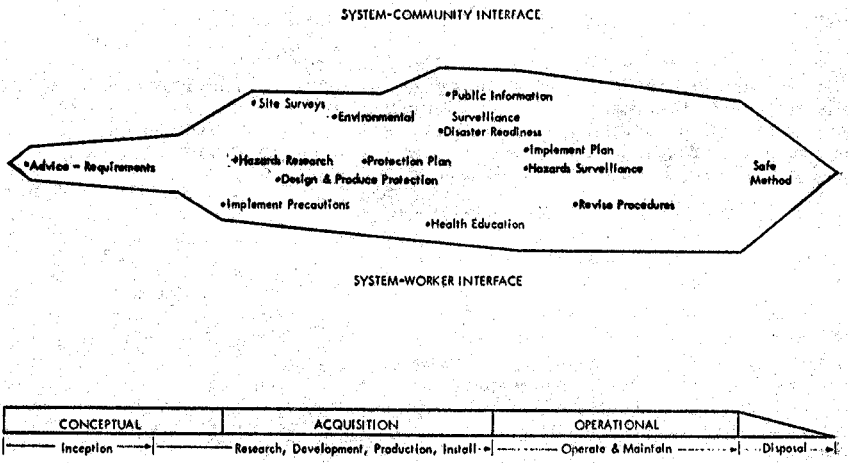


FIGURE 2. Typical considerations in systems analysis. In the analysis of the inplant-worker, and the plant-community interfaces environmental health considerations must take into account the state of knowledge as to potential hazards, as soon as possible. Based on these evaluations requirements are developed for research to be accomplished along with development of the system. Tentative health precautions and plans based on present knowledge are prepared. As results of research become available, health protection measures are finalized. Vigorous public information and worker health education measures are taken to reduce unwarranted apprehension. Once the system becomes operational, surveillance measures become routine, and protective measures are modified as experience dictates. When the system becomes obsolete, disposal of hazardous components must be in a safe manner.

at this point research was continuing on the development of environmental sensors and also on environmental pollution characteristics of the propellants.

During this phase, extensive ecological investigations were undertaken at the two principal military test sites. These involved the conduct of studies and investigations including laboratory analyses to determine the existing state of the environment in order that a base line could be available against which to measure the effect of any accident or any slow buildup of contaminants. Less comprehensive studies were also initiated with regard to each of the operational sites.

Since it was realized that the hazardous materials involved would have to be moved from the point of manufacture to test locations; would be involved in systems checkout at manufacturers' plants; and would have to be transported from the point of manufacture to operational locations (and ultimately from those operational locations to some point of disposition when the system became obsolete); a detailed systems transportation study was undertaken and appropriate precautionary procedures to provide for the event of a transportation accident. As the facilities were built and the operational components of the systems produced as part of the program of installation and checkout there was included evaluation and testing of the environmental surveillance devices and of the efficiency of the air and water pollution control measures.

As operational readiness was achieved all of these elements relating to protection of the environment were implemented. A necessary adjunct of the routine operations is the maintenance of environmental surveillance as well as a constant state of readiness to meet a possible accident or disaster. Throughout all of this effort there has been a conscious attention to the question of public relations and public information. It is noteworthy that the plan for coping with accidents in the case of this system has been tested in an actual disaster situation and found to be adequate, requiring only minor modification. In advance of

the time in which this system becomes obsolete, appropriate action is being taken to examine the question of disposal of large volumes of materials which have a major environmental pollution capability.

Some appreciation of the time involved and the magnitude of effort can be obtained from the fact that the initial efforts described above occurred approximately 70 months in advance of the operational capability. Directly concerned with the environmental pollution program were well over 100 military and civilian personnel of the Department of Defense. In this effort there were both detailed considerations of direct pollution problems and general studies in relation to other elements of the system including interior ventilation of facilities, the design of "hardware" and the general area of the operational sites.

The systems methodology is really not unique insofar as hazard evaluation is concerned. Most professional specialists in the fields of industrial hygiene and public health are familiar with the procedural technique of acquiring information regarding the environmental situation, the numbers of personnel who may be affected, the predicted physiological and psychological effect, and the technique of developing controls or alternative procedures, followed by the establishment of something which is often overlooked; namely, the checking and testing of effectiveness.

It is not necessarily so that they can be literally applied to the general problems of community environmental pollution. However, in conjunction with similar techniques, the complex socio-economic, legal and political considerations as well as those of purely technical importance, can be brought together. While we have evolved probably a more sophisticated approach to the problem of specific military systems, modifications certainly can be developed for both industry and community problems.

The Scientific Basis for Pollution Policy

Science and regulatory requirements

The most complex central problem with regard to pollution abatement is the translation of scientific knowledge into the program definition and the accompanying legislative and administrative requirements. It is quite apparent that this is a complex sociological, economic and political problem as well as one in the technical and scientific domain. Ecologically speaking, the environment is defined as the sum of the external conditions and influences affecting life and development of organisms. The human environment consists of biological, physical, and cultural influences. These are available techniques for determining the effects of physical, chemical and biological agents on isolated systems. The study of biological effects of environmental pollutants is susceptible to analysis in the fields of biology and engineering. On the other hand, there is a lack of both factual information and concepts to approach the total problem of environmental stress relationships. Witness the controversy with regard to the facts and opinions expressed in such books as Carson's "Silent Spring" and the wide variation of opinions relating to certain chemical and physical stress agents. As pointed out in a recent issue of *BioSciences*, widely varying opinions regarding the environmental pollution problem have been expressed by responsible scientists as follows:

Example One: "The number of deaths caused every year by pesticides is insignificant; smaller than the number caused by aspirin. Vital statistics do not reveal any increase in mortality that could be traced to the oxidant type of smog."

Example Two: "Grave delayed pathological manifestations can result from repeated exposure to concentrations of environmental pollutants so small that they do not cause obvious manifestation . . . The most serious effects of air pollutants may be those which are not detected at first and involve multiresponse of the organisms." In this current period of great emphasis on the problems of environmental pollution, there is a tendency to overlook the fact that the human species, as all other biological organisms, possesses a remarkable degree of adaptability. Mankind in particular has been able to achieve adjustment to the widest variety of environmental and psychological stress situations. As shown in Figure 3, because of this adaptability in the majority of instances there is no fine line between truly safe and absolutely harmful situations. In order to arrive at a truly scientific basis for environmental pollution abatement, or, more precisely, for the establishment of a more positive approach of maintenance of environmental quality, there must be a blending together of all of the elements involved.

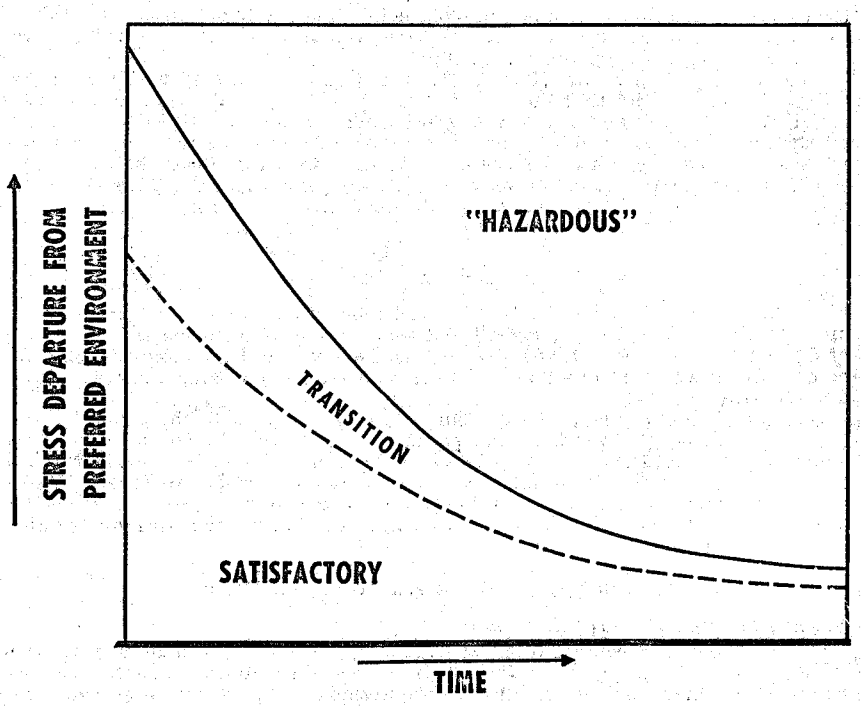


FIGURE 3

Legal and administrative requirements are an integral part of long-range as well as short-term plans for environmental pollution abatement. It is self-evident that legal methodology must proceed forward hand in hand with the scientific. The Department of Defense is required to comply with a variety of legal and administrative procedures. Our concern is that in this broad area, subject as it is to a variety of influences, there should be developed improved understanding of the true complexity of the problem. Regardless of the approach taken in arriving at the legislative and administrative requirements, there are certain fundamentals which appear to be absolutely essential. These include:

a. The necessity for determining whether or not the emphasis is to be upon performance standards or specific approval of equipment and practices.

b. The need for flexibility to provide for the future.

c. The recognition of the "test of practicality". This applies both to the feasibility of achieving what the law requires, and to the means of determination as to their achievement.

There is a major difficulty affecting the establishment of programs for environmental pollution abatement arising from the problems which have been cited herein as to establishment of a true measure of the environmental quality desired. Anyone who is familiar with the many difficulties inherent in the establishment of allowable concentrations for industrial environmental exposures is aware of the differences of opinion regarding the significance of some of the number values utilized in such expressions as "maximum allowable concentrations," "threshold limit values," and "acceptable concentrations." Based on experience in this realm of environmental exposure control, there is a need for better understanding of the difference between a standard and a criterion. As pointed out in the State of California's excellent publication "Water Quality Criteria" the term "standard" as used in an environmental sense applies to a definitive rule, principal or measure established by authority. The comments in that publication on criteria, objectives, requirements and standards are worthy of quoting here.

The term "standard" applies to any definite rule, principle, or measure established by authority. The key words in this definition are *definite* and *established*

by authority. The fact that a standard has been established by authority makes it quite rigid, official, or quasi-legal. An authoritative origin does not necessarily mean that the standard is fair, equitable, or based on sound scientific knowledge, for it may have been established somewhat arbitrarily on the basis of inadequate technical data tempered by a cautious factory of safety. Where health is involved and where scientific data are sparse, such arbitrary standards may be justified. There is a tendency, however, for regulatory authorities to promulgate standards of questionable scientific justification to serve as a crutch that facilitates administrative action and enforcement.

A far better word to describe an administrative decision by a regulatory body is "Requirement." It represents a requisite condition to fulfill a given mission. It does not necessarily have the connotation of scientific justification nor does it give an impression of immutability. Requirements are less likely to be as rigid or fixed as standards. In California, the regional water-pollution-control boards are directed to prescribe requirements for every existing or proposed discharge or sewage, or industrial waste, but such requirements may be revised from time to time (Section 13054 and 13054.1 of Division 7, California Water Code). Indeed, "No regional board, by prescribing requirements, shall be precluded thereafter from revising requirements relative to the same disposal area or receiving waters. A discharge pursuant to the prescribed requirements shall not create a vested right to continue such discharge under the same requirements" (Section 13002, Division 7, California Water Code). Examples of requirements by California WPC Boards are given in Chapter III.

The word "objective" represents an aim or a goal toward which to strive, and it may represent an ideal condition that is difficult, if not impossible, of economic attainment. Most certainly, however, it does not imply strict adherence nor rigid enforcement by a regulatory agency. It is gaining favor among engineers on boards and commissions that strive to achieve water-pollution control by persuasive methods and cooperative action. It avoids the rigidity and authoritativeness of standards and it does not have the enforcement element of requirements.

A "criterion" designates a means by which anything is tried in forming a correct judgment respecting it. Unlike a standard it carries no connotation of authority other than that of fairness and equity; nor does it imply an ideal condition. When scientific data are being accumulated to serve as yardsticks of water quality, without regard for legal authority, the term "criterion" is most applicable. For this reason, this report has been entitled "Water Quality Criteria." As a compendium of criteria, it should be useful in prescribing requirements in California, and it can be used as a guide by any agency that desires to establish standards or objectives.

To be useful, a criterion should be capable of quantitative evaluation by acceptable analytical procedures. Without numerical criteria, vague descriptive qualitative terms are subject to legal interpretation or administrative decisions. A criterion should also be capable of definitive resolution, i.e., unaffected insofar as possible by synergism, antagonism, or other complicating factors.

There is a tendency, which should be avoided assiduously, to let criteria become rigid and perhaps ripen into standards. For this reason, every criterion should be regarded as flexible information to be kept constantly under surveillance.

Establishment of quality criteria

The establishment of interim environmental quality criteria for those situations where no requirements have been promulgated by local, State, or Federal agencies is a function of the Medical Departments of the military services. In undertaking such tasks it has been recognized that in many instances the pace and progress of biological science, and the tools of ecological management have not kept pace with the advances in the physical sciences. Often available facts are not sufficient to support or contradict in a conclusive manner preliminary data. There are many pitfalls in attempting to extrapolate to the operation, or even to the test environment results of what are essentially biological or bioenvironmental investigations. Dr. Robert Kehoe, University of Cincinnati, in addressing the 2nd National Congress on Environmental Health at Ann Arbor, Michigan in June 1961 observed that the height of absurdity was reached "when one finds oneself soberly pondering the significance of a conventional mathematical expression of a borderline possibility concerning the effect or lack of effect of a given experimental procedure as

applied to white rats under the artificial conditions of the laboratory when the question is not what happens in the laboratory but what will be the effects in the variable conditions of life."

Instead of finite limits and strict numerical values as indicators of environmental quality, what appears to be most useful are ranges of environmental conditions, which are expected to produce certain predictable results. These multiple boundaries must be defined in such a manner that they can be measured. The method of measurement ought preferable to be applied to the environment, rather than to a biological response, although the effect can be quantified in such terms.

Lest there be any misunderstanding, on this subject, nothing in the foregoing should be construed as a plea for delay pending development of better knowledge or improved technology. As shown in Figure 4, the passage of time and the increase of information from observations and experimentation will provide for changes in the state of knowledge. Initial concepts, and procedures, based on the then available appreciation of the situation may be either confirmed, found to be too conservative, or not stringent enough. Emergence of a whole new technology, or disappearance of some element of the problem may also alter the situation drastically. The actions taken by the military departments in relation to several potential environmental pollution situations, for which well established rules or environmental quality standards were not available exemplify the approaches which can be taken to provide for the public welfare.

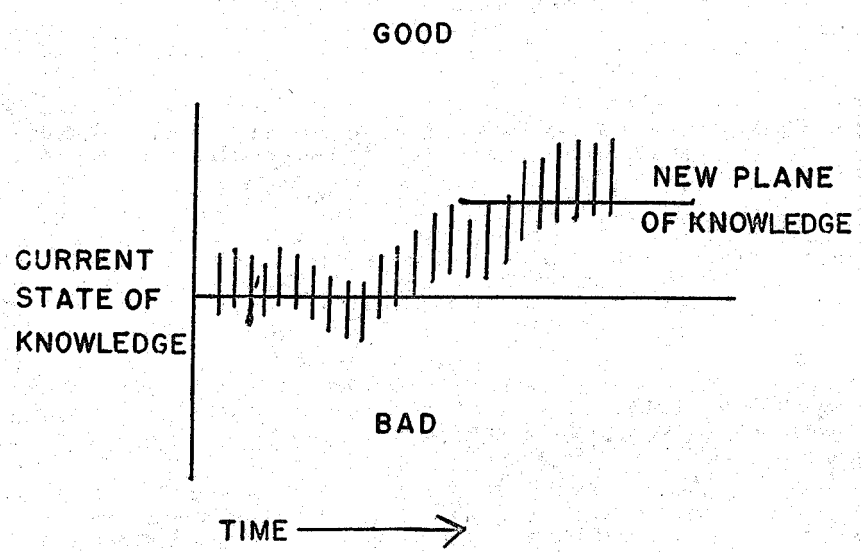


FIGURE 4

Typical of these actions to meet the needs of environmental pollution control, even in the absence of guidelines and standards, are those taken with regard to shipboard waste disposal, and waste from munition manufacturing operations. These represent situations in which both interservice and interagency cooperation has been necessary to a high degree. The Navy, Army, and Air Force alike operate vessels, and the U.S. Corps of Engineers in its Civil Works functions has a number of boats and surface craft on rivers and harbors. The nature of design of military vessels present some problems, and the needs of the dockside situation, as contrasted with open water operations are also different. Close cooperation is being achieved with the Federal Water Pollution Control Agency, and the U.S. Public Health Service to develop the necessary guidance as to performance and methodology.

In the case of the munitions manufacturing waste problem, both the Army and Navy are concerned in their own facilities, and those which are contractor oper-

ated. Extensive investigations conducted by the U.S. Army Environmental Hygiene Agency have been reviewed by the National Academy of Sciences Advisory Center on Toxicology, and again cooperative efforts are being undertaken on an interagency basis to develop appropriate guidance as to permissible concentrations of these materials in the environment, and to use these as the basis for engineering design of abatement works.

Of special interest are the programs regarding environmental pollution associated with rocket and space propellants. Many of the materials which have a possible use in this program are known to possess toxic and hazardous properties. In some instances there is incomplete data even with regard to routine occupational exposures. In other instances difficult situations are presented in attempting to determine the environmental quality values for non-occupational off-site situations. A major effort has been undertaken within the Department of Defense to provide for adequate protection against air and general environmental pollution hazards arising from our research, development, test and evaluation programs. This matter has been of some concern in recent hearings of the Senate Special Subcommittee on Air and Water Pollution, and is a matter of major opinion by the military departments concerned. Considerable testimony regarding this subject was presented in the 1964 Senate Subcommittee hearings and in 1965 before the Subcommittee on Public Health and Welfare of the Committee on Interstate and Foreign Commerce of the House of Representatives. A summary of information on the precautions associated with this material are included in the report of the hearings on S. 3112 before the Subcommittee on Air and Water Pollution of the Committee on Public Works, United States Senate (reference pages 443–453). It is worthwhile to point out in addition that here again, in the absence of definitive legislative or other regulatory requirements, initiative has been taken by the Department of Defense to provide to the extent consistent with available knowledge for the protection of the health of the population. The actions taken by the Air Force and the other military departments involved have been based upon appreciation of the need for the most thorough evaluation of the many facets of the problem. During the four year period of Fiscal Years 1964–1967, approximately $1,700,000 was expended in investigations on the atmospheric dispersion of beryllium particles from testing of rocket propellants; on testing and evaluation of sampling and analytical procedures and on fundamental toxicological studies. The Department of the Air Force has maintained close coordination with the U.S. Public Health Service so as to provide for an exchange of information. We have recognized that the problem is one in which there are major epidemiological implications and are depending upon the U.S. Public Health Service to furnish us with the necessary evaluations and guidance in that regard. Micrometeorological studies and investigations on this and other rocket propellants provide information which may be useful in civilian industry and communities.

It is generally agreed that the industrial occupational exposure limit values should not be used as a basis for establishment of air pollution quality values insofar as continuous exposures are concerned. The rocket propellant test operations, on the other hand, represent air pollution situations generally discontinuous in nature and of extremely short duration. Some guidance as to permissible exposures can be obtained for on-site personnel from the industrial guidelines. Careful scrutiny of epidemiological data, toxicological studies, and the application of value judgments on the industrial levels can be utilized while more precise information is being accumulated. The application of the science of micrometeorology is also involved in determining and assessing possible distribution of contaminants in the environment. A summary of some of the more important air quality criteria for liquid propellants is provided in Figure 5, and for some other chemical substances in Figure 6. It is emphasized that these are not community air quality values, and are furnished only to give an appreciation of the difference in effects of various concentrations.

There is a major possible contribution to knowledge and technology needed in air pollution resulting from this work. Among these are the improvements in diffusion prediction methodology, environmental sampling techniques, and in the realm of administrative rule making. This last, in company with the experience in interdepartmental coordination and industry cooperation may be of the greatest significance to the future.

AIR QUALITY CRITERIA FOR LIQUID PROPELLANTS
(Values in PPM * Unless Otherwise Noted)

SUBSTANCES	Hygienic Standards for Daily Occupational Inhalation — Type "C" Values (1) TWA (1)	Type "C" Values (1) Peak Values	Short Occupational Exposure Limits	Immediately Hazardous to Life	Emergency Occupational Exposure Limits (6) Exposure Time - Minutes 10	30	60
Alkyl Boranes-Skin (HiCal-3,HEF-2,HEF-3)	< 0.01 (13)	(HEF-3 & HiCal-3 are not very volatile but can produce enough vapor to cause toxic effects. HEF-2 is rather volatile. HEF-3 and HiCal-3 are more dangerous than HEF-2 (11).					
Aniline-Skin	5	(Skin penetration is more of an industrial hazard than inhalation) (14)	50-100 (3)	Unknown, but 100-160 for 1-hr causes serious disturbance. (2) Air is saturated at 340.			
Chlorine Trifluoride		0.1	(1 proposed)	Unknown, but 50 may be fatal in 15-30 minutes (12)	7	3	1
Diborane	0.1		(2-4 proposed)	Unknown, but 300 for a few minutes may be dangerous. (3)			
Diethylenetriamine (DETA)	Unknown - Because of tendency to skin & pulmonary sensitization, all exposure must be reduced to lowest possible level. (3) DETA does not have good warning powers. (12) Due to its low vapor pressure, it does not vaporize readily at normal temperatures, and little respiratory irritation is evident. (12) Sensitization is the primary hazard.						
Ethyl Alcohol	1,000	2,000	5,000-8,000 (2) (3) (10)	Unknown, but impossible to tolerate 20,000. (10)			
Ethylene Oxide	50	100	300 (10)	Unknown, but severe injury or death likely at 2,000 for 1-hr. (10)			
Fluorine	0.1	0.5	1 (3)	Unknown, but 50 could not be tolerated (3)	3	2	1
Fluorine Pentabromide	Unknown		"	"	"	"	"
Furfuryl Alcohol	50	100	"	"	"	"	"
Hydrazine-Skin	1		(10 proposed)	Unknown, but rats exposed to 100 for ½-hr showed significant mortality from pulmonary edema. (3)			
Hydrogen	Non-toxic		"	"	"	"	"
Hydrogen Peroxide, 90%	1	5	75 (3)	Unknown, but concentrations in excess of 1000 would probably be lethal after a few minutes. (3)			
Inhibited Red Fuming Nitric Acid (IRFNA)	2	5	(10 proposed)	"	"	"	"
Monomethylhydrazine (MMH) - Skin		0.2	(10 proposed)	"	"	"	"
Nitrogen Tetroxide as NO_2		5	(10 proposed)	200-700 (3)	30	20	10
Nitrogen Trifluoride	10	NF_3 provides no odor-warning properties at potentially dangerous levels. (2)					
Oxygen	Non-toxic		"	"	"	"	"
Oxygen Difluoride	0.05	0.1	The extreme toxicity & insidious character of OF_2 makes it imperative to exclude its inhalation by personnel.				
Ozone	0.1	0.3	(1 proposed)	Unknown, but 50 for 30-min might produce fatal results. (3)			
Pentaborane	0.005	0.01	(0.1 proposed)	Unknown, but a few ppm for a few minutes may result in serious effects. (3) Odor threshhold is 0.5-1 ppm. (3) (14)			
Perchloryl Fluoride	3	10	(30 proposed)		(90)	(60)	(30)
RP-1	500	1000	(2,000 proposed)	Unknown, but % concentrations probably required to produce fatal results.			
Unsymetrical Dimethyl-hydrazine UDMH-Skin	0.5		(30 proposed)	2,400 (4)	100 (6) 300 (4)	50 (6) 150 (4)	30 (6) 50 (4)

*PPM - Parts of vapor or gas per million parts of air by volume at 25°C and 760 mm Hg pressure

FIGURE 5

AIR QUALITY CRITERIA FOR OTHER CHEMICAL SUBSTANCES
(Values in PPM* Unless Otherwise Noted)

SUBSTANCE	Hygienic Standards For Daily Occupational Inhalation			Short Occupational Exposure Limits	Immediately Hazardous to Life	Emergency Occupational Exposure Limits[6]		
	TLV's					Exposure Time - Minutes		
	TWA[1]	"C" Values[1]	Peak Values			10	30	60
Acetone(acclimated) (Unacclimated)	1,000 (500)		2,000 1,000	4,000 2,000	Unknown - Similar to ethyl alcohol except narcotic effects are somewhat greater.			
Anhydrous Ammonia	50		100	400[2] 100[10]	5,000-10,000[2][10] 20,000[3]	- -	- -	- -
Benzene(benzol)-Skin		25						
Beryllium(occupational)	0.002 mg/m³			0.025 mg/m³ for < 30 Min[3]	-	-	-	-
Beryllium(non-occupational)	0.00001 mg/m³							
Soluble compounds BeO				0.0025 mg/m³ 0.05 mg/m³	for 30 minutes with a minimum interval of 2-weeks[11] for 30 minutes with a minimum interval of 2-weeks[11]			
2-Butanone (methyl ethyl ketone)	200		300	500[10][14]	Unknown - but probably >10,000[3] marked irritating properties should prevent ill effects.			
Butyl Acetate	150		200	400	Unknown, but rats died when exposed for 8 hrs to saturated air at 2,000.[14]			
Butyl Alcohol (N-Butanol)	100		200	300	Unknown, but saturated air at 68°F has a concentration of 6,200 where marked narcosis and irritation is experienced.			
Carbon Dioxide	5,000			50,000[3]	100,000[3]	-	-	-
Carbon Disulfide-Skin	20			50	4,615 fatal in ½-hr[3]	200	100	50
Carbon Monoxide								
Normal	50			400	5,000[3]	1500	800	400
Mental Acuity	50			200	5,000[3]	1000	500	200
Carbon Tetrachloride-Skin	10		25	75	Unknown, but 1000-2000 for ½-1 hr resulted in fatalities.[3]			
Chlorine		1		4	1,000[2]	-	-	-
Chlorobromomethane (Methylene chloro bromide)	200		400	600	Unknown, but probably 2-3%[7]			
Chloroform (trichloromethane)		50		200	Unknown, but 14,000-16,000 will cause rapid loss of consciousness[3].			
o-Dichlorobenzene		50		200	Unknown, but saturated air at 77°C has a concentration of only 2,000.			
1,2 Dichloroethane (ethylene dichloride)	50		100	200	Unknown, but % concentrations probably required to produce fatal results.			
1,2 Dichloroethylene	200		1,000	2,200	Unknown, but rats were anesthetized in 8 min at 16,000 and killed in 4 hrs.			
Diisobutyl Ketone	50		100	200	Unknown, but irritating properties at 500 ppm can only be tolerated for more than a few min.[3] Saturated air of 68°F has a concentration of 1,580.			
Ethyl Acetate(acclimated)	400		800	800	Unknown, but 1-2% dangerous for short exposures.[14]			
(unacclimated)	200		400	500	" " " " " "			
Ethyl Alcohol (Ethanol)	1,000		2,000	5,000	Unknown, but 6,000 to 9,000 is initially intolerable to the unacclimated subject.[11][13]			
Ethyl Ether	400		500	600	Unknown, but 35,000 anesthetizes in 30 min.[14] 100,000 may be fatal.[3]			
Ethylene Glycol	Vapor hazard exists only when handling at elevated temperatures. Saturated air at 77°C is 131.							
Formaldehyde		5		Concentrations above 5 are highly objectionable and levels above 50-100 may cause serious injury.[12]				
Gasoline	500		1,000	2,000	Unknown, but anesthetic death probable at 20,000-30,000.[12]			
Hydrogen Chloride		5		10.	1000-2000[3]	30	20	10

FIGURE 6

AIR QUALITY CRITERIA FOR OTHER CHEMICAL SUBSTANCES
(Values in PPM* Unless Otherwise Noted)

SUBSTANCE	Hygienic Standards For Daily Occupational Inhalation TLV's TWA[1]	"C" Values[1]	Peak Values	Short Occupational Exposure Limits	Immediately Hazardous to Life	Emergency Occupational Exposure Limits[6] Exposure Time - Minutes 10	30	60
Hydrogen Cyanide-Skin	10			30	270[2]	-	-	-
Hydrogen Fluoride	3		5	8	Unknown, but highest conc. tolerated for 1 min was 122[10]	20	10	8
Hydrogen Sulfide	10		20[8]	50[8]	Unknown, but 600 fatal in 30 min[14]	200	100	50
Methyl Chloroform (1,1,1-trichloroethane)	350		500	1,000	30,000[3]	2000[4]	3000[4]	1000[4]
Methyl Chloride (dichloromethane)	500			2,000	Unknown, but short exposure above 10,000 may be dangerous.[5]			
Naphtha (coal tar)	100		200	400	Unknown	-	-	-
Naphtha (petroleum)	500		1,000	2,000	Unknown, but anesthetic death probable at 20,000-30,000[14]			
Perchloroethylene	100		200	400-600	Unknown, but 5,000 could only be tolerated for a few minutes.[3]			
Sulphur Dioxide	5			10	Unknown, but 400-500 considered danger-ous.[2]	30	20	10
Toluene (toluol)	200		300[8]	500[8]	Unknown, but 8,000-12,000 rapidly fatal to mice.[3] An exposure to 4,000 for 5 min or less will probably allow self-rescue with no irreversible injury.[8]			
Toluene Diisocyanate		0.02		0.5[3]	Unknown, but 600 ppm for 6 hrs is lethal to rats.[9]			
Trichloroethylene	100		200	400[3]	Unknown, but % concentrations probably required.			
Trichlorotrifluoro-ethane (Freon TF or -113)	1,000		5,000	10,000	Unknown, but saturated air concentrations at 40,000 can cause almost immediate incapacitation.			
Xylene (xylol)	100		200	400	Unknown	-	-	-

*PPM - Parts of vapor or gas per million parts of air by volume at 25°C and 760 mm Hg pressure.

FIGURE 6—(Continued)

ADMINISTRATIVE AND POLICY PROBLEMS

The manpower problem

There is a current shortage of persons with the requisite skills in both the technical aspects of pollution abatement and in the broad abstract approach to maintaining and improving environmental quality. The expansion of knowledge in the technical areas has not been matched by an accompanying expansion in the numbers of persons skilled in the various bioenvironmental and science and engineering areas. Many observers are quite aware of the fact that to deal with the technical and sociological problems an interdisciplinary approach is required. There is a need for both "generalists" as well as specialists and considerable attention in developing what amounts to a new technology in this area is a major necessity.

In 1962 there were only 4,900 individuals listed by the National Science Foundation's National Roster of Scientific and Specialists Personnel as practicing "sanitary engineering." At that time there were only 100 students in training. Requirements in the fields of air and water pollution and solid waste disposal for the next several years obviously outstrip the current availability of personnel. The military, medical, and civil engineering departments are facing increasing difficulties in obtaining and retaining qualified scientists and engineers to discharge our obligations under current directives. The increasing requirements in all of the allied health professions are similarly affecting our abilities to maintain a capability in the various sciences necessary to staff and administer our programs. It is our view it is vital to the Federal interest that those personnel working for Federal departments concerned with pollution control have equal or even better capabilities and technical know-how than those in industry or in the State and local administrative authorities. Without such capability neither the leadership desired in the Federal establishment can be provided, nor can the departments such as the Department of Defense be in a position to develop the adequate and economical procedures and programs necessary to conform to environmental pollution abatement regulations. The situation affects, we might add, the total medical service capability, as well as those relating to the problems of environmental pollution. At the present time, in the purely technical areas there are deficiencies in the output of the required engineers and scientists and there are also needs for expansion of the scope of the

educational programs for these individuals. Since this is a multi-discipline effort, there is also a pressing requirement for greater depth of knowledge and understanding on the part of all of the disciplines involved, not merely those concerned with the physical and biological attributes of the environment. While much progress has been made in this regard, much remains to be done. In particular, if the Federal Government's departments and agencies are "to exert leadership" considerably greater attention must be given to the manpower and personnel policies designed to equip the individuals and agencies with the highest level of professional talent.

Insofar as the Department of Defense is concerned, there are numerous problems with regard to personnel policy pay and compensation which are currently being given extensive study. It is anticipated that these specialized task requirements will be given recognition in whatever recommendations are finally submited to the Congress.

Local and Federal cooperation

Suggestions regarding division of responsibility for evaluation of pollution situations between local and Federal technical groups are more properly within the province of the Division of Air Pollution, U.S. Public Health Service and the Federal Water Pollution Control Administration and the Solid Waste Division, U.S. Public Health Service. However, the subordinate activities of the Department of Defense are faced with the necessity as previously cited in this report for complying with both local and Federal regulations and enforcement authorities' requirements. Accordingly the department has a vested interest in this sphere of activity. Based on some of our experiences, some observations and recommendations are hereby submitted.

a. There is an obligation on the part of the Federal departments and activities to work in consonance with local and other Federal agencies on those problem areas arising from new research and development programs. As indicated previously, often the agency responsible for the program or project has more knowledge about the subject than the administrative or regulatory authority. The efforts exerted by representatives of the U.S. Public Health Service, the Department of Army, Department of Air Force, and the State of Utah Public Health Department in dealing with propellant waste disposal problems in that State, as reported in last year's hearings on the Clean Air Act, exemplifies the type of cooperative effort which can be undertaken by the Federal Government, State and local authorities, and civilian industry.

b. There is a manifest need for improving the paths of communication between the various professional disciplines involved in pollution and abatement in both the Federal and in local authorities and between the pollution expert and those concerned with the development of administrative regulations. The efforts currently being exerted within the Federal establishment to bring together the views of those in the departments affected by pollution abatement rules with the representatives of the enforcement agencies such as the U.S. Public Health Service and the Federal Water Pollution Control Administration give an indication that such cooperative efforts can be fruitful and provide for a more rational approach as to who shall do what to whom and under what circumstances. There does exist a need for better education of State and local officialdom of the intricacies of the budgetary and appropriation procedures of the Federal Government. The necessary long and involved arrangements and the many steps between establishment of a project and ultimate approval by the Congress and appropriations of the funds simply is not well understood. The military construction program cycle normally requires something over two years from time of initiation of a project to allocation of funds for implementation. The Federal departments and agencies under existing procedures may be less able to repsond promptly to local and State requirements than civil industry or municipalities. This situation is another cogent reason for the establishment of national plans for the Federal departments.

Consideration of costs versus benefits

A number of questions have been raised in the Report of the Research Management Advisory Panel relating to human health as a measure of ecological management and as to the question of the cost of benefits to achieve "normal population health." The military departments have had to exert a considerable degree of effort in analyzing the economic implications of environmental pollution control measures. Any measures concerned with the achievement of a

particular desired environmental quality involves a series of economic judgments as well as those relating to the system's effectiveness or the desirability of adoption of a particular program or progress which involves a potential hazard to the environment.

One of the first and most essential steps which must be taken is the assessment of the cost of pollution damage. Such costs may be extremely high in terms of effects on military operational capability or in terms of damage to adjacent persons and properties. With increasing degree of controls there should be a reduction in the potential costs arising from the presence of the environmental pollutant. The costs of controls accordingly are offset by the savings in expenditures to compensate for the damage.

On the other hand, at some point, very, very little return is obtained for the incerased costs of control measures and the effective costs may approximate that which would have resulted had no effect to minimize or mitigate the pollution situation been taken.

In regard to the problem of determining costs, the question must be ascertained as to what is the uppermost and principal effect of the pollution situation. Human health must be recognized as being unquestionably the most important of the various categories of environmental pollution damage. This central requirement of consideration of effects of health of man cannot be overlooked. Department of Defense policy, as contained in the previously cited DoD Directive 5100.50 establishes the following priorities of effort.

a. To those situations which constitute a direct hazard to the health of man,

b. To those having economic implications,

c. Those which effect the recreational and aesthetic value of our natural resources.

In applying these policies, consideration is given to nuisance and irritation to humans, to effects on livestock and wildlife, property damage, effects on land use, and deterioration or alteration of desirable attributes of the environment.

Summary

The Department of Defense and its subordinate activities have recognized that the problem of environmental pollution require vigorous efforts as part of the total national program. Its efforts like those of the other Federal departments and agencies must be exerted as part of a coordination of public and private efforts at every level of government and in every sector of our economy and society. As enunciated in the Report of the Research Management Advisory Panel to the Committee on Science and Astronautics, there are voids in our knowledge, opportunities for new technology, deficiences in the existing technology and a need for some new concepts. If a long term overall good is to be achieved, there is a need for:

a. An assessment and marshalling of knowledge on the various elements of the pollution problem,

b. The undertaking of those measures which will solve within existing capability and technology the identifiable near term problems.

c. Through proper forward looking efforts to anticipate and delineate the larger problems of the future, and

d. The undertaking of research and coordinated effort so as to develop the necessary level of understanding and knowledge of the subject,

e. Provide a means for new designs and the development of interdisciplinary efforts to expand both knowledge and practice in the problems of ecology.

Department of Defense activities will continue to cooperate toward meeting these needs by continued action thereon within its sphere of responsibility.

(Whereupon, at 11:55 a.m. the subcommittee adjourned until Thursday, July 28, 1966, at 10 a.m.)

THE ADEQUACY OF TECHNOLOGY FOR POLLUTION ABATEMENT

THURSDAY, JULY 28, 1966

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT,
Washington, D. C.

The committee met, pursuant to adjournment, at 10:08 a.m., in room 2325, Rayburn House Office Building, Washington, D.C., Hon. Emilo Q. Daddario (chairman of the subcommittee) presiding.

Mr. DADDARIO. This meeting will come to order.

Our first witness this morning is Mr. Bertram C. Raynes, vice president for applied research, Rand Development Corp.

Would you please come forward, Mr. Raynes?

We are pleased to have you here this morning, Mr. Raynes, and we want both to apologize for not having you here yesterday and to thank you for being kind enough to stay over for this morning's meeting.

Mr. RAYNES. It was a pleasant evening for me yesterday.

Mr. DADDARIO. Please proceed.

STATEMENT OF BERTRAM C. RAYNES, VICE PRESIDENT FOR APPLIED RESEARCH, RAND DEVELOPMENT CORP.

Mr. RAYNES. Mr. Chairman, gentlemen, thank you.

It is an honor to be invited to make a statement before this committee and to speak on the subject of the adequacy of present technology for pollution abatement. My remarks are more personal than corporate, but they are, I believe and I hope, professional.

To the question: Is presently available science and technology adequate for pollution abatement? My answer is: No. The technology—the application of scientific knowledge to practical purposes—is obviously not adequate, for if it were, there would be less compelling reasons for these hearings. Even where adequate science is easily available as it is for many kinds of contamination, it is not being applied, or is being applied only partially. Of course, more and better science is needed, especially in the handling of certain contaminants, but the best science remains academic without aggressive application.

To the further question: What do we need to do to combat environmental pollution? My answer is: Apply now what science is known to remove those contaminants which can be removed and handled, while simultaneously improving the technology and discovering the new science needed.

In answering this way, I find myself somewhat at odds with—as only one example—the report of the Research Management Advisory

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Panel, submitted July 1, 1966, to this committee. I do agree that there is no good present technology for the treatment of certain pollutants; by good, one means both effective and reasonable in cost. But I disagree that our environment is being so increasingly polluted because of a technology gap; rather, it is because of a management gap. It is just unreasonable to accept as fact that those technicians who have contrived to make our increasingly complex industrial technology economical cannot also devise means to deal with solid, gaseous, or liquid pollutants in the wastes from their processes.

I do not agree that the future pace of pollution abatement must depend entirely upon new science or technology—certainly not its immediate future pace. The major sources of polluted waters, ugly refuse heaps, and for a substantial part of pollution in the atmosphere, are in the management offices of industrial and municipal plants of all descriptions. It simply is so much cheaper and so much less trouble to dump stuff or vent stuff than it is to take care of it, that production management will dump and vent just so long as it can get away with doing it.

There are two ways to get production management to take action to deal with their wastes in the kind of workmanlike manner they apply to their production problems:

The first is to make them want to. Somehow get individuals who have already coped with a long list of responsibilities to accept one more, and to proceed to clean up their wastes because it is right and proper. Possibly to get production management to acknowledge that they too breathe the air, drink the water, take vacations, and that their own health and enjoyment are at stake.

This approach hasn't worked at all in most instances, works poorly and ineffectively in others, and even when successful, it's generally too late.

The second is to force them to take care of their wastes properly. Simply to require that the water they dump be pure, regardless of its condition when they receive it. That the gases they vent be free of pollution. That their spoil doesn't in turn despoil other property or remain ugly, regardless of how poor the area might have been when they undertook their operations.

On the assumption that it will be the latter case—that production management must be made to take care of its own wastes—it can be presumed that the Federal Government will provide the force. Local and State governments haven't done the job.

There will be some active dissent from production management. If you care to offer some relief, and you may, may I plead that it not be in the form of extensions of time to pollute? If any relief be offered, it should be in the pocketbook. Except where the technology actually doesn't exist for pollution control, wastes should be cleaned up.

This point brings me to the gap in technology management. The way I see it, pollution abatement technological management spends almost all of its time in identifying problems, developing analytical techniques, and the like—and almost no time on solving problems. The result too often is a multitude of surveys and tabulations of data which have the effect of masking the problems, not illuminating them.

In the water pollution abatement area, these surveys lead to confusion and to very narrow viewpoints. A recent Cleveland, Ohio, newspaper item reported, in quotes, a statement which seems to summarize the narrowness which a surfeit of surveys can bring about. Before an Ohio legislative subcommittee looking at pollution elimination, testimony was given that "the crux of the pollution problem isn't the effluent, but what is happening in that river * * *." I submit to you—and I hope this is actually the larger view—that the river is not at fault. Rivers are the victims, not the villains.

That philosophy is wrong. That approach is wrong. The goals must not be to find out how much filth a stream can be made to accept, nor the limits on emissions into our air, nor the extent the land can be brutalized. Pollution abatement management—at every level, in public or private service—spends too much time in figuring out how much it can get away with, when it should be figuring out how properly to remove and handle as much of the pollution load as it can. The way matters stand now, both production management and also abatement management are interested in getting the environment to accept as much untreated or poorly treated contamination as it can. The environment doesn't stand a chance unless both of these managements change their approach. The most impressive science doesn't stand a chance to become useful technology unless the philosophy be changed.

The goal must be to clean up after ourselves to the point that any escaping pollutants are the result of accidents, of naturally occurring phenomena, or because their cleanup is clearly still outside present science or technology. The goal must be clean air and clean water, not tolerances and limits, and not how much we can get away with for a while longer. Unless the philosophy and goals are reassessed, the brightest technological advances won't pay off any more than present practice is paying off in keeping our environment clean.

I have listed a few specific jobs that I might recommend. The first is to get one or both of the technological and production managements to act forcefully to take care of their waste problems, not simply to catalog them. There are dust collectors and precipitators, chemical and bio-oxidation procedures, reclamation devices, shovels and rakes. Those can be put to use now, without waiting for anything new.

Next, I urge the increasing use of pilot programs, demonstrations, field evaluations, and similar efforts to bring developing science to commercialization as soon as possible. These should be relatively large-scale efforts examining wastes as they are generated or exist, not laboratory simulations. The programs should be authorized to have flexibility without penalty. If a fault be found in technique or equipment, it should be fixed and the work pushed to a successful conclusion if any way at all can be found; a fault should be considered an opportunity for improvement, not a process failure. The philosophy in such programs should be that they will be made to work. Technological difficulties should not be used as an excuse to continue polluting. In essence, pollution abatement work should be undertaken in the same way that production processes are undertaken; some product must be attained at the lowest cost and the highest efficiency. The payoff in pollution abatement should be on the same

basis and the product should be a clean effluent, and a safe and nonpolluting disposal or reuse of the removed wastes.

Without increasing use of large-scale, broadly based, pilot programs, adoption of improvements in waste treatment will continue to be too slow. Such programs must be encouraged at the Federal level, and usefully at the State and local levels, as well as in industry. Every project director must have the desire and the freedom to get working solutions to pollution problems, and not just to accumulate data.

Since my own work has been mostly in the water pollution abatement area, I think mostly in terms of that particular problem area.

I urge that the Federal Water Pollution Control Administration be authorized to set up a trouble-shooting group composed of experienced, practical men to help sewage treatment plant operators out when they have operating problems. And they do have problems. I have in mind a group which can help get a troubled plant back on stream quickly, and this group to be financed so that it can travel to the scene of difficulty. Sometimes there is a limited municipal budget for such travel, and help becomes essentially unavailable.

To help make such an effort effective, I urge that sewage treatment plant operators be encouraged to disclose their difficulties, and not be penalized or ostracized for having them.

As one incidental comment, there's a fad today of calling a sewage treatment plant a "pollution control center." That doesn't clean up sewage; it doesn't even clean up the language.

The subject before the committee is environmental pollution. It's a big topic, so wide ranging ideas should be appropriate. I therefore urge that consideration be given to upgrading the local zoning board concept, a concept which makes intelligent control of environmental pollution difficult. Zoning controls should include ecological considerations as well as the tax duplicate. As an example, homes or businesses should not be allowed to be built on flood plains, flooded out, and then to use their plight to push for the damming of free-flowing rivers. Natural drainage areas should not be automatically assigned as fill areas or garbage dumps and so forth. Whole riverfronts or lakefronts should not be given over to industry and commerce without the respite of green areas. Natural areas should not be abandoned to indiscriminate abuse of their land, water, and air—and simply thereafter called the heavy industrial zone. A new approach is needed in this area.

Antipollution programs should be designed to deal with as many pollutants at a time as possible, not just one where more are already recognized. Work to remove sulfur dioxide from stack gases is commendable, but programs should be going on to get entirely clean effluents—cleansed of all known or suspected pollutants. It should be accepted now that when the SO_2 is gone there will be nitrogenous compounds; let's work on them in this generation of ideas and men.

The same thought could be applied to the refuse problem. There's garbage, cans, bottles, cardboard, automobiles, sewage sludge, aluminum foil, and industrial residues of all kinds. There are programs for garbage, and programs for junk cars, and programs for residues. I urge the situation be looked at as the refuse problem, and big solutions looked for and found for the whole problem. That is w-h-o-l-e. It could be the big hole, h-o-l-e, problem, though.

On the subject of poisons such as the pesticides, a reversal of typical attitudes might be helpful. Instead of comforting the public with statements to the effect that "there is no evidence that these pollutants have unfavorable effects upon humans," let's see some evidence that they are definitely not harmful. Sometimes the background to the statements which begin "there is no evidence that * * *" really is that there is simply no evidence whatsoever. One way or the other.

I submit that there should be less dialog on pesticides and more facts. Establishing how much poison an animal species can withstand by killing specimens off by varying their exposure to it, is still basically the same old how-much-can-we-get-away-with approach. We should know how poisons kill, the mechanism by which they work, and then we could evaluate their long-range effect more intelligently. And, perhaps decide that some of them should no longer ever be used at all.

Others have testified before you or will testify to additional areas where new technology is needed, on incentives of one sort or another, standards, and on policy in pollution abatement. My thesis is that pollution abatement philosophy should be to clean up all wastes and effluents to the maximum extent possible now, and with known means, while new science is being obtained. The goal should be to improve upon these methods to make them more economic and increasingly more effective. The aim should be to reduce the pollution loads on our waters, land, and atmosphere, not to force them to accept more. The standards should be fresh air, pleasant vistas, and clear, clean waters. The activity should be to put newly developed methods into use just as soon as they become available, and to do whatever is necessary to speed the development of improvements in these methods to make them increasingly more effective and economical.

Thank you, sir.

Mr. DADDARIO. Thank you. As we have proceeded with these hearings, Mr. Raynes, I can't remember anyone who has disagreed with your basic thesis that everything possible should be done now with what is available to us. We must also seek new methods of abatement. But I do think that even though we accept this thesis, there may be differing opinions as to how to get there. I wonder how you apply that to your own feeling about the wrong approach to the situation. On page 3 of your statement you say the goal must not be to find out how much filth a stream can be made to accept. Some people appear before us and say that we should apply standards and that we ought to find out what a river contains and what it can stand. Are they wrong in accumulating information of that kind so that they can develop a program which takes into consideration the situation around them. Isn't it true that you could not possibly begin to solve the problem unless you knew where you stood, how much time you had to correct it, and what the pressure of the environment around you was at that particular time? Don't you oversimplify the issue by saying that this is not something that ought to be done?

Mr. RAYNES. That approach is one that I do not agree with, sir.

Mr. DADDARIO. How do you get around it since it exists, sir?

Mr. RAYNES. Well, I would suggest cleaning up the effluents and seeing what happens to that river. Instead of surveying and then

making an estimate of what might occur 5 years from now, simply clean up all the effluents and see what the river does. I have witnessed a very contaminated river begin to recover itself in as short a period as 9 weeks when certain industrial effluents stopped being dumped into it.

Mr. DADDARIO. Well, let's take a big proposition which has been put before us—the expenditure of some $25 to $30 billion for separating sanitary and storm sewers. Some people say we ought to begin this program immediately and make arrangements to spend this money. This is a big program which falls into this proposal of yours. Since a solution is available and we probably could obtain the moneys to do it, should we do it or should we in fact take a look at the environment within which this whole program would be developed to see what the causes and effects of it might be?

Mr. RAYNES. Of course I don't think every survey is ill-considered. Many of them are very worthwhile and should be carried out and used. Concerning this particular subject you are talking about, I particularly do think that all facets should be carefully thought out, both the separation and also the expenditure of such funds. But there are many other situations where it is quite obvious that cleaning up, for instance, an oily waste would be beneficial; that is the sort of individual situation I don't believe needs to be evaluated any further.

Mr. DADDARIO. The reason I asked you that question was that I thought you had that in mind. It seems to me that we ought to try to take that perspective because there is so much in what you say.

Mr. RAYNES. I don't believe that surveys made so that intelligent decisions can be based on them are not worthwhile. They certainly are. But surveys to continue the license to pollute I disagree with.

Mr. DADDARIO. On that particular point, somewhere in your report you talk about programs that ought to be authorized and that ought to have some flexibility without penalty.

Mr. RAYNES. Those are pilot programs; yes, sir.

Mr. DADDARIO. You are taking into consideration that there are some problems.

Mr. RAYNES. Oh, sure.

Mr. DADDARIO. And that this must be considered.

Mr. RAYNES. But I believe it is the same kind of problem any production process faces. Someone designs a production process and builds a plant. Take a chemical plant; he starts it up and maybe the product isn't quite right the first week. Perhaps the yields are somewhat low or the costs are a little bit too high. He doesn't automatically abandon the whole idea. He goes ahead and works on his problems until he gets them fixed. I believe that pollution abatement technology today is available for many or most pollution problems, but it is not being applied. Does that answer your question?

Mr. DADDARIO. Yes. As I understand your statement and as I understand your philosophy about this, it boils down to the recognition of the need to apply the technology which is available to us today which is not being used, and which could be done easily. You did, in fact, make a point about shovels and rakes and I quite agree with you, but I think that as we overcome those basic problems which can

be taken care of with information available to us, we still do not overcome the great bulk of the pollution problem which stands before us. You direct your efforts and your thoughts to the solving of this through better management practices and through these pilot programs.

Mr. RAYNES. Pilot programs to get the new science to the commercial stage as quickly as possible.

Mr. DADDARIO. Using the example of the separation of sanitary and storm sewers, I would expect that that would be one area in which some pilot work might be helpful.

Mr. RAYNES. Yes, sir.

Mr. DADDARIO. Mr. Raynes, how do you think we should put together the findings and evaluations of the pilot programs or demonstrations? Do you think this is a Federal responsibility alone or should we bring in both industry and State governments?

Mr. RAYNES. I think it has become a Federal responsibility since, in general, no one else has done it. I think it would be very nice to encourage the participation of industry and of State governments and even of local governments. If you could get it somehow, that would be very, very helpful. But as the matter stands now as I understand it, it is up to the Federal Government to provide not only the money but the impetus.

Mr. DADDARIO. One of the suggestions you have, and I think it is a good one, is to set up a troubleshooting group composed of experienced men. Do you make that suggestion because it would be possible, considering the manpower situation, to put together teams of that kind whereas it would be extremely difficult to develop that kind of competence at each level where work of this kind is needed?

Mr. RAYNES. No, I actually made that suggestion because, in one of our projects we are carrying out in my company for the Federal Water Pollution Control Administration, we are attempting to find a more economical and beneficial disposal of sewage sludge from existing conventional sewage treatment plants. The concept is to use the sludge in the reclamation of areas which themselves pollute, such as strip mine lands. When we go to a sewage treatment plant and ask them if we can have some of their sewage sludge, the operators will be very, very pleased to let us have it because its disposal is the biggest headache in the treatment of sewage today.

However, quite often these fellows say: "Well, you know, I'm having trouble with my digestor and it has been out of service a couple of months. I can't get it back on stream." And we inquired of many of them: "Why don't you get some help someplace?" The only thing they can do, really, is make a telephone call or write a letter. They don't have travel funds. A small town can't afford to or won't send its sewage treatment plant operator here to Washington or to Cincinnati or wherever it is required he go for help, and so the guy just has to struggle along. Sometimes the struggle might take a half year, and during all that time the receiving water below the sewage treatment plant is getting more polluted than it should be getting.

Mr. DADDARIO. Then this does get us back to manpower capability. You have people running some of these plants who are not able to handle these problems themselves because they do not have sufficient technical training.

Mr. RAYNES. Any good technical man will accept help when he has a problem, if he can find it.

Mr. DADDARIO. The object is to make available the opportunity to go to a central source?

Mr. RAYNES. Yes. Or to have help come to him.

Mr. DADDARIO. You don't eliminate the possibility of placing responsibility on a State or local area as well?

Mr. RAYNES. No indeed, sir.

Mr. DADDARIO. Have you any reason to believe that industry is becoming interested enough in pollution abatement to go to a company such as yours to have work done for them?

Mr. RAYNES. They have—yes, I see signs. Many companies are now beginning to look into water pollution. Industry is beginning to recognize, I think, that there are business opportunities there for one thing. That incentive is plenty strong, very worthwhile.

We do see it. Rand Development has not been approached as yet by any company to undertake research work. Contract research and development is the basis of my corporation's charter. We haven't had very much of that, but we have had people come and want to talk to us about the possibility of cooperating with us in the pollution abatement field.

Mr. DADDARIO. You used the example of a man running into difficulty with his plant and having to spend 6 months waiting for help or working to get it back into shape instead of being able to go to a central place for immediate aid. How about the problems of poor design and inadequate facilities which confront the people who run these plants? Don't they need to have some kind of advice available to them to supplement what they already have with new techniques?

Mr. RAYNES. I think that would be a very worthwhile addition. As much help as they can get, as much frankness about the problem as they could give.

Mr. DADDARIO. This falls within the category of unused potential which we already possess.

Mr. RAYNES. Yes, sir; I believe that.

Mr. DADDARIO. Mr. Conable?

Mr. CONABLE. I don't want to belabor this license to pollute point any more. I think I understand what you are saying. We really have a priority problem though, don't we? Assuming there is a limited resource in this field—and I am afraid we have to assume a limited resource in every public field—we are going to have to decide where the pollutants are doing the most damage and we are going to have to continue to survey the practical matter regardless of what our ideal point of view would be.

Mr. RAYNES. I hope not but I suppose that is the practical side of the matter. I'd prefer to see it otherwise.

Mr. CONABLE. I understand your point and I think the how-can-we-get-away-with point of view is a dominant one in the field.

Mr. RAYNES. I am afraid it is.

Mr. CONABLE. I don't see any practical way to get away from it completely because we can't just clean up every stream tonight.

Mr. RAYNES. No; I don't think it can be done by nightfall. But we could get started by then.