and the processes lend themselves to closed-cycle operation with a minimum of byproducts or waste product throwoff. But there is constant pressure to reduce costs and this is one of the best ways to reduce cost, to close the cycle.

Mr. DADDARIO. Mr. Roush?

Mr. ROUSH. Mr. Chairman, as I heard this testimony, I had the very distinct impression that the chemical industry is very conservative in its approach to the solution of this problem. Over the past 2 or 3 years, I have sat on another committee of this Congress studying the pollution problems as they relate to water and it has been my consistent impression that the chemical industry is one of the greatest polluters of our streams. As a matter of fact, I sat in a meeting in Rochester, N.Y., when this gentleman was testifying as to what the chemical industry had done. We found that the Hooker Chemical Co. was among the polluters of the streams. This conservative attitude in approaching a problem which the industry has imposed on the public doesn't really go down too well with me.

You state that you are spending $8 million annually on air and water pollution control research. I'm wondering what percentage of your total research and development budget that figure represents.

Mr. LOGAN. Let me clear the record. The specific statement was that a survey made in 1962 showed that people were spending at that rate—this is date of about 1960. I personally feel that it may be double that today. I don't have any more recent data, so I think we must recognize that the $8 million figure is out of date.

Mr. DADDARIO. It would be helpful, Mr. Logan, if you could get for the record a more up-to-date figure which would reflect the change which has taken place in your industries since that $8 million figure was determined.

(Information provided regarding this request is as follows:)

Respecting the chemical industry's expenditures for research on wastes treatment and air and water pollution control, we reported 125 companies were spending more than $8 million annually as of 1962, of which $5.5 million related to water pollution and $2.8 million related to air pollution. Comparable current figures are not readily available. We will request such information again from our member companies in implementing our expanded program in environmental health but it will take several months to compile it since companies must gather it internally from a considerable number of sources. When the information has been compiled, we shall be pleased to furnish it to you and the Subcommittee.

Mr. LOGAN. One of the efforts that we recognize that is currently needed is an up-to-date survey of our industry in terms of what it is doing in pollution abatement, what it is doing in pollution abatement research, and also what it is discharging in the way of waste, and this is a part of our current forward program but we do not have such data other than the 1962 survey at hand.

Going back to Mr. Roush's remarks—one of the difficulties is with the general use of the term "chemical." You go along a stream and you see an unusual color or sediment of some sort and you say, "Well that's some chemical." This may have had absolutely no connection with the chemical industry but the term "chemical" covers practically all of the science-based industries.

It can cover petroleum industry wastes; it can cover paper industry wastes; it covers the detergent industry problems. So I think when we

talk about chemicals, this is one thing, and chemicals do not necessarily mean the chemical industry per se.

I would disagree with your opinion that the chemical industry as such has been a major or the major contributor to pollution. We do have serious problems, however, no question about it.

Mr. ROUSH. Mr. Logan, let me challenge another one of your statements and then hear your comments.

On page 8 of your testimony, you state:

> Except in programs of giant proportions such as space exploration, it is our impression that greater opportunities for industry to engage in research supported by Government contract would not generally be a substantial stimulus to progress.

Now, I am under the impression that most pollution is chemical in its nature. It would seem to me that within the chemical industry there would be great scientific talent which the Government could look to in its attempt to solve this problem and perhaps through this type of arrangement arrive at solutions which would benefit this country of ours. I don't understand why you would make this statement.

Mr. LOGAN. Let me see if I can clarify that point. I agree with you that—and I believe this was your remark—that most wastes or most pollution is chemical. Actually, all things are chemical and we must distinguish the chemical industry and chemical things. You and I are chemical. This glass is a chemical. The industry is basically, therefore, fundamental to all other industries, and it is fundamental to all aspects of the solution of the pollution problems. The industry has a number of companies, a number of the members of MCA where the chief business, the primary business of these companies is in the treatment of water for various purposes.

Sometimes it is the treatment of boiler feed water or it is the treatment of municipal wastes, but there is a large segment of the chemical industry that is devoting 100 percent of its attention to problems of water.

There is a vast supply of technical ability in our industry that can be directed to the solution of these problems. The specific statement we made tried to convey the fact that we do not believe the best approach is to engage a specific member of industry or a specific section of the industry in a Government program. We do feel that the industry, through the MCA or through the technical groups of the industry should be allowed to contribute, should be allowed to review and participate in the formulation of programs designed to minimize waste disposal problems. This was not a statement that we did not wish to do so. It meant to imply that we did not think research engaged in under Government supervision in a specific plant or company was the best approach to the problem.

Now, maybe I have not answered your question. Maybe I have confused you.

Mr. ROUSH. I understand that this response is based on an apparent conservative philosophy concerning Government participation and Government solution of problems. That's the way I would view it. I believe that's all, Mr. Chairman.

Mr. DADDARIO. Mr. Vivian?

Mr. VIVIAN. I would like to say to you that I think the chemical industry as such is not the worst polluter. I think some of the worst polluters are those companies which buy equipment and turn it on and pay no attention to how it works. But it is certainly true that the chemical industry produces some materials that are exceedingly dangerous.

On page 5 of your testimony are some figures for a 1962 survey. You indicate that 125 members invested approximately $500 million in pollution control facilities and approximately $64 million annually to operate these facilities. Do you mean per year or for what period of time?

Mr. LOGAN. Prior to that time.

Mr. VIVIAN. Total prior investment?

Mr. LOGAN. Yes, now let me give you another figure if you would like to have it.

We cannot absolutely confirm this. It is in the form of estimates by qualified people in the industry to the effect that the industry currently is spending somewhere between 2 and 5 percent of its total capital investment for facilities related strictly to waste disposal or pollution control.

In other words, out of every hundred million dollars spent, $2 to $5 million—and this will vary from place to place. But, since the industry has been spending capital at approximately $3 billion a year, 2 percent means $60 million per year and 5 percent means $150 million per year. I think this range is much closer to the current figure than the figure cited as of the amount that had been expended until the date of the survey.

Mr. VIVIAN. About a hundred million dollars a year is your best estimate?

Mr. LOGAN. Yes.

Mr. VIVIAN. If I were to take this $500 million which you indicated as a prior investment and prorate it over a 10-year period, it would probably come out somewhere between $50 and $100 million a year as your estimated cost for capital.

Mr. LOGAN. I would expect it is on the higher side and moving up both as a percentage and as an actual amount all the time.

Mr. VIVIAN. You indicated $60 million as operating expenses. Suppose we round that off to a hundred million dollars. That would be an estimate of approximately $200 million capital and operation cost. What's the total sales volume in the industry?

Mr. LOGAN. Between $25 and $30 billion a year.

Mr. VIVIAN. So, we are talking about $200 million out of $25 billion, right?

Mr. LOGAN. It is on the order of 1 percent.

Mr. VIVIAN. One percent. As a matter of fact, that corresponds quite well to some estimates made for me by some others who are present in the room. It seems that 1 percent is a pretty small fraction of the product cost, although I recognize it is a significant portion of profit.

Mr. LOGAN. Yes, that is 1 percent of the ultimate sales basis. It is substantially larger in terms of the product cost. It is a higher percentage in relation to the product cost and much higher percentage in relation to the profit.

Mr. VIVIAN. I don't think product cost is necessarily the right word to use, but it is still a very small fraction of your total sales cost. If you were to double your efforts in pollution abatement, this would be approximately another 1- or 2-percent factor of product cost. It could affect your profits slightly more than that, but those would be differential profits across the industry. They would not be necessarily affected very much at all. So, there is much room left in the industry for pollution abatement. I think you will agree with me.

Mr. LOGAN. No question; and your arithmetic is correct; yes.

Mr. VIVIAN. Now, the next question I have is related to the study of massive research. On page 5 of your testimony you refer to the need for evolutionary development from a combination of operating experience and constant research attention. I would agree with that. This is the only way in which most work progresses. But what do you mean by a massive research effort scattered on a broad front? What horrible image did you have here that you were trying to knock down?

Mr. LOGAN. I think the term "massive" was more with reference to a systems-analysis approach. We feel that it is not in all cases in the best interest of society to proceed to carry to the ultimate the control of waste disposal and pollution by existing techniques and by decisions made without the benefit of an analysis that incorporates many factors beyond our control: social, economic, transportation, and so forth. Therefore, we suggest that a systems-analysis approach incorporating not only the factors over which we in the chemical industry have control but other factors—climatic conditions, labor conditions, market conditions, unemployment—a thousand and one. These are the criteria that have to be subjected to an overall attack in order to come up with the best cost-benefit solution to waste disposal. In the long run that will best serve the public interest. We are prepared to provide our contribution to that kind of an attack but we cannot do that ourselves because it involves factors outside our knowledge and outside our control.

Mr. VIVIAN. Are you suggesting then that the Government should carry on what I will call the massive research effort related to a cost-benefit analysis, or are you suggesting that you don't want industry to carry it on? I'm trying to find out what these words mean.

Mr. LOGAN. I'm suggesting that this has to be done, and that since in our opinion it cannot be done by us as an industry, it will be difficult to be done by any other industry involved. Therefore, maybe this is an area where the Government could move forward.

Mr. VIVIAN. On page 5 of your statement, you point out that 95 percent of the daily waste water volume met the public agencies' requirements in effect at that time. Does that suggest that the remaining 5 percent was in violation of the law?

Mr. LOGAN. Either that they were in violation and were working on the problem or that there were no public regulations applicable.

Mr. VIVIAN. I couldn't read the words as meaning that there were no regulations applicable. It sounds as though the 5 percent was in violation of the law.

Mr. LOGAN. I can't answer the details of that question. I'm not certain of that.

Mr. VIVIAN. The reason I bring up the point is, I think there has been a serious laxity in enforcement of the laws. The laws exist and the public health officials are aware of them, but because of the apprehension that the plants might move away, the laws are ignored. I have very specific knowledge of that subject in my own district.

Mr. ROUSH. Would the gentleman yield?

Mr. VIVIAN. Yes.

Mr. ROUSH. In addition to this matter of fear of plants moving away, I want to ask this related question: Is there any inclination on the part of members of your industry to move to those areas where there is no control?

Mr. LOGAN. My answer to that is "No." Mr. Roush, I have operated production facilities in our company and I would say that our policy certainly does not decide the location of a facility on that basis. Every request for capital coming to our company at the moment has to be certified with complete information as to the problems of disposal that are involved in the particular installation. The decisions regarding location are made on other bases; raw materials, markets, and transportation.

Mr. ROUSH. This is not even a small factor?

Mr. LOGAN. No, sir; I didn't say that it isn't one little factor because I am not privy to the reasoning used by everybody who makes a decision on a plant location, but as a general matter, the matters of raw materials, markets, and transportation are so significant that these become controlling factors.

I would assume that if we looked, we could find specific instances where someone said, I will put a plant at location A because the pollution regulations are less vigorously enforced than they are at location B. But, as a general matter, I don't think this is significant.

Mr. ROUSH. Thank you, Mr. Vivian.

Mr. FULTON. Would you yield, Mr. Vivian?

Mr. VIVIAN. Yes.

Mr. DADDARIO. Mr. Fulton?

Mr. FULTON. If 95 percent of the 10 billion gallon daily waste water is in accordance with the law of those reporting, obviously one-twentieth of it is not. That is 500 million gallons a day of waste water that are violating the law from the 875 companies who reported, and we would assume that only the best would report because they have the best records. The bad ones wouldn't report. Would you comment on that?

Mr. LOGAN. Yes. Several comments.

Mr. CONABLE. Excuse me. Would the gentleman yield?

Mr. FULTON. Yes.

Mr. DADDARIO. Mr. Conable?

Mr. CONABLE. I assume there must be a number of municipal corporations that are in rather serious violation of the law also, isn't that so?

Mr. FULTON. On that point, might I say that the Federal Government in Pittsburgh, in none other than the Fulton Building, was paying sewage disposal charges to the Allegheny County sewage disposal unit, but at the same time they were not using it. They were dumping the sewage directly into the Monongahela River, and had

been doing it over many years. Would you comment on my point, though, to the extent of the pollution by the daily discharge of waste water? Thank you.

That is all, Mr. Chairman.

Mr. LOGAN. Yes. The 500 million gallons is a small quantity, actually, in terms of the volumes of water that we talk about in this country both for private usage and industrial usage. The chemical industry itself is not basically a large consumer of water. So, point 1, the 500 million gallons is not large in terms of water usage, and it is small in relation to the fact that it is spread over a great many locations.

With regard to the matter of reporting, I can't answer the question of whether there was any selectivity in the reporting. Maybe I can get an indication of the total number of plants in our membership at the moment. Do either one of you know that?

Mr. FULTON. I would assume that your membership are all "good guys"?

Mr. DADDARIO. You could supply a more accurate number for the record, Mr. Logan, rather than find out now.

Mr. LOGAN. Yes; I think the reporting at that time was roughly 85 percent of the total number of plants. I don't know which type or where.

Mr. FULTON. For Mr. Vivian, Mr. Roush, and myself will you submit a statement?

(Information provided regarding this request is as follows:)

With reference to the total number of chemical plants represented in MCA membership at the time of the 1962 survey mentioned in our prepared statement, we estimate this to have been in the vicinity of 1100. While it may seem odd to give an inexact figure, active growth in the chemical manufacturing industry has been such that new plants are constantly being built, while occasionally old ones are discontinued. Thus the number of plants engaged in production of chemicals is continuously changing.

Mr. WILKENFELD. There is one other point on this. That is that half of the remaining 5 percent indicated that they were under a program approved by their local agency leading to compliance with existing regulations.

Mr. VIVIAN. Mr. Chairman?

Mr. DADDARIO. Mr. Vivian?

Mr. VIVIAN. I should say to the gentleman I suspect that a number of the industries involved were under tolerance agreements and I want to point out that 95 percent is not an advertising factor. You refer to industry standards both in your written statement and oral comments. It is apparently your desire that industry standards not be applied on that industry-by-industry criteria should not apply to all plants of a given type. You said that would cause chaotic results. Perhaps it would. You say, for example, that it would perhaps be tolerable in one place in view of the market conditions that exist, but that it would completely force a plant out of operation in some other part of the country. I want to refer to a plant which is out of operation in my district. The plant happens to be a bathing beach. The reason it is out of operation is that the total accumulated flow of waste coming down the Detroit River is so enormous that the bathing beach is posted as not fit for swimming.

If you go up to the River Rouge, which flows through the main manufacturing area of Detroit, you would find that it wouldn't make any difference there because there is no public interest left in the River Rouge other than to get as far away from it as possible. The public interest could be served by dumping waste material into the River Rouge, but the River Rouge dumps it into the Detroit River; and the Detroit River dumps it into my district, and we do not go for that. We also have industries that threaten to move away from my district if we enforce pollution standards. We do not look upon this as favorable, particularly when they move to some other portion of the State where the laws are not as tight as ours. They pollute some other river and eventually it goes into the sea. It would seem to me that we do have a hazard. If we begin to enforce reasonably tight pollution standards, we will cause factories to move to the ocean shores, where many have already moved, and they will proceed to dump into the oceans where there is no one downstream to argue with them.

Now, I regard that as a pretty insensible approach to the problem.

Mr. LOGAN. Let me come back to your question. I agree with much of what you said and I have no doubt that there may be plants in the chemical industry that should be shut down and moved. But these situations generally involve factors other than the matter of waste disposal.

I have been, in my discussions, suggesting the movement of plants for other reasons. To close down and move a plant today with all the problems you get into is a pretty tough proposition. I think there are some plants, where that needs to be carefully considered, but this should involve the area or the locality, and some method of analysis which takes into account factors other than purely the problem of the plant itself.

Mr. VIVIAN. Earlier, I got you to agree that you were spending about 1 percent of your sales volume on pollution abatement. Then I find plants saying they are going to move if we enforce the laws. Now, what that means to me is that these plants possess a wonderful club to use on local communities, but one which is not necessarily valid if viewed by an economist dealing with the total product cost.

Mr. LOGAN. You are averaging out. The 1 percent might be 25 or 50 percent in one case and zero in a number of others. You cannot average that out.

Mr. VIVIAN. I agree.

Mr. LOGAN. Now, let's get back to the point of moving to the oceans.

Mr. VIVIAN. Go ahead.

Mr. LOGAN. If you plotted the weight of the chemical industry throughout the country, I think you would find that it is heavily located along the gulf or coastal areas or on navigable waters. This is not brought about by the desire to avoid pollution control. It is brought about by raw materials, transportation, and markets. There may be the isolated case where the waste disposal problem is a contributing factor in the decision, but basically the chemical industry is located on the navigable waterways. This facilitates the movement of raw materials. Also it facilitates the movement of finished prod-

ucts to the market, and that means that you are largely related to the ocean, to the gulf and the main river bodies.

Mr. VIVIAN. As you have pointed out, that tends to be the gulf coast, the east coast, and the Great Lakes. I'm omitting the west coast because there does not seem to be a dispute there. No one has yet succeeded in saturating the gulf or the Atlantic coasts that we know of, but the Great Lakes are being saturated and that has occurred in the last generation. Therefore there is a trend toward plants moving away from the Great Lakes. I happen to have a district on the Great Lakes which has something to do with my question. Now, the question I have is: "If we set industry-by-industry standards on effluent control, why would this be dangerous to industry?" You say that it intermixes with other factors in the market equation and could cause plant relocations. Presumably it would cost unfair amounts at some seacoast locations. That's the only interpretation I can place on your statement.

Mr. LOGAN. Not in most cases I think, and I'm not familiar with the specific plants in your locality, although I know some of them pretty well, I think in many cases if the decision regarding plant locations were made today, those people would not have put the plants where they have put them in your territory.

Mr. VIVIAN. That's another worry. Go ahead.

Mr. LOGAN. That is right. So, a part of the problem is related to that factor and is not at all a reflection of waste disposal problems. We talked about organic chemicals a few moments ago. Actually the organic chemical business is based on hydrocarbon raw materials, gas or oil. These are essentially gulf coast or port based situations. This is largely why you have the tremendous development along the gulf coast. It is a matter of raw material and fuel. It is not related to pollution per se.

Mr. Chairman, Mr. Wilkenfeld would like to comment on one of Mr. Roush's remarks with respect to the situation in New York State.

Mr. WILKENFELD. I think you will be very interested in what developed after the Rochester hearing in which the question was raised about the quantity of biochemical oxygen demands being discharged by one of our Hooker plants. At that time the report which Congressman Jones had indicated there was 22,000 pounds per day being discharged. He felt this was an extremely large figure and questioned it, and I said I would go back and investigate it further. I discussed the matter with the Director of the Federal Water Pollution Study on Lake Ontario immediately afterward. He agreed that he would find out the basis for this number. He didn't know offhand and I have written him formally requesting this, and haven't had a reply yet. I also went back and checked on some data developed on samples taken by the Federal water pollution agencies for the International Joint Commission in the spring or late winter last year. I think it was December or January. Their results indicated that there were only 1,600 pounds a day of biochemical oxygen demand, not 22,000, and the concentration—which I tried to indicate was an important fact, not just total pounds—at two discharge points to the river was 2 and 15 parts per million, which are well within what the Federal water pollution agency has indicated they felt discharges to the Great Lakes and

Detroit River should be limited to. They talk of 20 parts per million as what they would like to see municipal plants and industries meet in their discharges. So, our discharges were within this, and this was why I was so unsure. I remembered these figures, but not precisely and didn't want to get too involved before I made certain. So I think it is important to set the record straight.

Now, the other aspect that bears on this whole question is that if you calculate the effect of this particular plant's discharge on the Niagara River and assume that you have only 10 percent of the flow available for distribution—and I select 10 percent of the flow of the Niagara River because this is the flow in the American channel—this becomes less than two-tenths of a part per million of biochemical oxygen demand in the stream.

Now, I haven't looked up what the normal biochemical oxygen demand in that stream is, but I think it is well over two-tenths of a part per million, and under one part per million is considered reasonable in a stream. So there are these things that arise and sometimes misinterpretations can be placed on figures. Other times in attempting to develop information, things can be looked at in manners that aren't exactly a complete picture.

Mr. ROUSH. I want to make it clear that my first statement that the chemical industry is one of the greater pollutors of our streams was not based on that particular figure.

Mr. WILKENFELD. Well, as you realize, I'm sensitive about this particular point.

Mr. DADDARIO. Mr. Vivian?

Mr. VIVIAN. I have a very brief question, but if he wishes to respond to a previous question, I will be glad to wait.

Mr. WILKENFELD. There is one other point I should make. This reduction or discharge of 1,600 pounds a day—to cite a specific case—resulted from a great deal of effort over 10 years to reduce waste loadings by inprocess modifications, and inprocess changes, and inprocess treatment of a chemical engineering nature which does not correspond to secondary treatment. This is a plant that produces a lot of organic chemicals, and this is why we feel so strongly.

On the other point of this whole business of research, I would like to make one other comment here. To our mind the concept of a systems approach and a major effort at developing new approaches to pollution abatement is radical rather than conservative. It is our feeling that we have to find completely new ways for the future. The currently accepted techniques, if we applied them completely to all our effluents, both domestic and industrial, would probably bring the waters back to an acceptable quality.

But, looking ahead 10, 20 years, I think we recognize that this is not going to be enough and this is why we feel so strongly that it is necessary to find completely new approaches, not necessarily only treatment, but new ways of doing things.

Mr. VIVIAN. Mr. Chairman, I recognize that time is passing but I would like to make a brief comment.

The statements you make on the bottom of page 7 of your statement that continues over to page 8 regarding the relative roles of organizations is a very pertinent one. You suggest that the Federal Govern-

ment can play a role in determining criteria, knowledge of the science to establish criteria, and in participating and improving the operation and design of municipal treatment works, and other similar functions in which there is no industrial role.

The stimulus for research by industry and the private sector is a force whereby your own funds and capitalization can be used to develop new technologies and change your processes to minimize cost. I think these are all very pertinent. Do you find any place where joint sponsorship is desirable between the Federal Government and industry, such as pilot plant operations? Let that be a question for the record rather than one to be answered here.

(The reply to this question may be found in vol. II.)

Mr. DADDARIO. Yes, because we do have another witness, and we are running out of time, so if you could keep what you want to say short, Mr. Logan.

Mr. LOGAN. Mr. Chairman, we have not talked much and none of the questions have borne on the hazard of toxicity. I wonder if Dr. Zapp could comment on that.

Mr. DADDARIO. Mr. Bell has a question first.

Mr. BELL. Mr. Logan, being from Los Angeles, my questions will be on air pollution. From a technical viewpoint do you honestly feel that existing air pollution research in chemical plants has been adequate enough to reach an understanding about the effect it will have on human beings?

Mr. LOGAN. I can't answer your questions specifically. I think Dr. Zapp is going to comment on this type of thing. In general we find that the people who work in our plants are less subject to hazards than when they get home and out on the streets. This leads us to believe that there is a technology here that if applied broadly could drastically improve the situation. We can take care of our people as long as they are under our control. It is when they get out on the streets and get home is when they are in trouble. And, this comes back to knowing more about what are the critical limits that people can be exposed to and what is the degree of hazard and maybe Dr. Zapp can take 1 minute and then we will move on.

Mr. BELL. Do you want to comment on this?

Dr. ZAPP. I will, sir. This is not a prepared statement and I will try to make it very brief but I think what Mr. Logan is getting at is that the toxicologist, which is one who is concerned with the toxic actions of materials, is concerned with two things: With toxicology itself, or the toxicity of material, which is the inherent ability to produce injury or death; and also is concerned with hazard, which is the probability that injury will occur under a given set of circumstances of use.

In the chemical industry we deal with chemicals of all grades of toxicity, from the extremely toxic to the practically nontoxic. We handle the extremely toxic materials with the hazard in mind; that is, can we do it under such circumstances that the probability of injury will be very little? We set criteria which are applicable for the, say the atmospheric concentration of chemicals in the atmosphere. Now, these are not zero, and experience has indicated that it is not necessary, or perhaps even desirable to get them entirely out of the air.

The desirable thing is to keep them at a level where they will do no harm. I feel that in this instance we have to keep our eyes on the desired goal, which is to protect the quality of the environment and as long as that can be maintained, it may be desirable for many reasons to admit certain wastes into these natural resources, under controlled conditions and in controlled amounts. Because ultimately we must dispose of all waste into some natural resource.

Mr. DADDARIO. I believe Mr. Fulton has a question that falls in this category.

Mr. FULTON. The question comes up as to what the environment originally was. To me it is a natural resource. Your philosophy does not accept this as a starting point and I think this injurious point that we are speaking of is along this line. For example, on page 2 of your statement, you speak of injuries to the very purposes and normal desirable life patterns which should be sustained. We can look at it from a conservation point of view and feel that we must maintain a happy, pleasant environment that keeps the natural resources, land, water, and air that we have inherited. Now, your organization looks at it the other way. It is the laissez-faire approach. For example, on page 3, you say that pollution abatement means reducing the injury after it has occurred and that prevention means keeping the injury in control.

My position is different from that. I think we should have the control to keep it to the minimum. The capacity of our environment to accept waste is an extraordinary valuable natural resource. But, you say it is the firm conviction of the chemical industry that society cannot afford the cost of control. Maybe your industry can't but society or this Government should. You see, it is a different concept.

One last point: You say that many of our most objectionable environmental conditions are not health matters. This may be true, but they may be depriving us of something that we originally had that we want. I don't make the distinction solely on the basis that it does not harm my health and, therefore, I will let every industry admit all the waste into the atmosphere, the lakes, the rivers, the streams and the oceans that they will hold.

The last part of this question is this: On page 5 of your testimony you state that:

> Although we shall always be interested in decreasing the cost, this is much more likely to come about gradually by evolutionary development from a combination of operating experience and constant research attention than by massive research effort scattered along a broad front.

I disagree with that strongly because that is saying, "Go as far as you can and then gradually cut down the waste when it becomes injurious." And in the next sentence, of course, you want to set interim objectives at conservative levels with subsequent tightening.

That means to me after the damage has occurred. As scientific and expert opinion provides justification, why not set the controls and enforce the abatement for everybody with uniform rules?

Mr. DADDARIO. Keeping that question in mind, I think probably we should have Mr. Bell ask another question.

Mr. FULTON. Put it in the record.

(This material may be found in vol. II.)

Mr. BELL. You spoke a few moments ago about keeping this toxic smoke emission down to a low level. What studies have you made based on the long-range, low-level type of operation as to what effect it will have in the long run, say 20 to 30 years? I would like to have you tie your answer to your experience or knowledge of the situation in Los Angeles if you could.

Mr. ZAPP. I think, sir, there are two kinds of answers we can give to that. For many citizens, there is historical experience, such as with silica—many things of this type that have been with us for centuries. With others, with the newer, particularly organic chemicals, experience begins with the discovery of the compound.

Now, my own laboratory has been in existence for more than 30 years so that on some things we have at least 30 years of human experience backing up the laboratory work. The Food and Drug Administration of the United States has been making judgments of safe levels of food additives, pesticides, and so forth, based in large part on animal experimentation, and then confirmed by careful observation of human population. We are doing the same thing. I think that the animal data give us a good basis for making estimates in respect to human safety, realizing that these must be confirmed by survey, epidemiological type studies as time goes on.

Mr. BELL. You include, in your studies, Los Angeles, too?

Mr. ZAPP. I have no studies in Los Angeles in particular, no.

Mr. BELL. But you are familiar with that situation?

Mr. ZAPP. I'm familiar with that situation; yes, sir.

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

Mr. DADDARIO. Mr. Logan, I regret that even though we have taken up a great part of the morning, we can't continue because we have a whole series of questions still to be answered and we hope we might send them to you and have your cooperation in answering them. (Additional questions and answers for the record may be found in vol. II.) We appreciate you and the other gentlemen coming.

Mr. LOGAN. Thank you very much, Mr. Chairman.

(The biographical statement of John O. Logan follows:)

BIOGRAPHICAL STATEMENT OF JOHN O. LOGAN, EXECUTIVE VICE PRESIDENT, CORPORATE, OLIN MATHIESON CHEMICAL CORPORATION

John O. Logan is executive vice president responsible for such corporate staff functions as law, patent, marketing services, engineering and construction, personnel, internal communications and Olin's Washington office. He also serves as chairman of the Capital Appropriations Committee. He was appointed to his present post in September, 1965, and in October became a member of the board of directors.

He joined Mathieson Alkali Works in 1931 as an assistant in the research department at Niagara Falls, N.Y., and his 35-year chemical career has covered research, sales and administration. Upon the merger of Mathieson Chemical Corporation with Olin Industries, Inc., in 1954 to form Olin Mathieson Chemical Corporation, he was named vice president and general manager of Industrial Chemicals. He became a corporate vice president in 1960 and the following year was put in charge of the Chemicals Division. In August, 1964, he was named executive vice president for chemicals, responsible for both the Chemicals and the Agricultural Divisions.

Mr. Logan was born on December 7, 1910, in Alton, Ill. He received his B.S. degree in chemistry and mathematics from Shurtleff College in 1931.

He is chairman of the board of directors of SunOlin Chemical Company and Nilo Barge Line, Inc.; chairman of the executive committee and a director

of the Manufacturing Chemists' Association; and a director of Penn-Olin Chemical Company (jointly owned by Pennsalt Chemicals Corporation and Olin), the National Agricultural Chemicals Association, the Chlorine Institute and the National 4–H Service Committee. He also is a member of the Chemists' Club, the American Association of Textile Chemists and Colorists, and the Technical Association of the Pulp and Paper Industry.

Mr. Logan holds several U. S. patents on pulp bleaching and generation of chlorine dioxide.

Mr. DADDARIO. Our next witness is Mr. A. J. Wagner, Chairman of the Tennessee Valley Authority.

He is accompanied by Mr. F. E. Gartrell. We would appreciate if you gentlemen would come forward.

STATEMENT BY A. J. WAGNER, CHAIRMAN, TENNESSEE VALLEY AUTHORITY

Mr. WAGNER. We greatly appreciate this opportunity to describe for your committee TVA's experience in the field of air pollution control.

TVA has long been concerned with this problem. Like clean water, clean air is an important environmental factor affecting a region's capacity for growth and development. As a regional resource development agency we are, therefore, interested in any condition or situation which impinges on air quality in the Tennessee Valley area.

TVA also has some direct responsibility for air quality control because we operate a number of large coal-fired, steam-electric generating plants which currently burn from 20 to 25 million tons of coal per year. We have a further direct responsibility because of our chemical plant operations at the Muscle Shoals fertilizer and munitions research and production facility.

We understand that the subcommittee is particularly interested in our experience in dealing with air pollution control at our steam-electric generating plants. Our serious studies of this problem began when we undertook construction of our first post-World War II plant at Johnsonville, in west Tennessee, in 1949. We located this plant and have since located others in rural areas. This has enabled us to generate electricity essential to the region's progress without adding to air pollution problems in large population centers. In fact, the growing use of electricity for heating homes and factories and offices and for cooking in our cities has reduced the smoke and pollution which would otherwise have resulted from stoves and furnaces in the cities themselves. Heat transmitted by wire from rural generating stations to our region's cities has helped to keep their air clean.

In addition to this location factor, we have for the past 15 years conducted a continuous program of study and research in steamplant air pollution control. Its purpose is to insure that, even in rural areas, the operation of our plants is carried out to hold undesirable discharges into the air within acceptable limits.

This program has been under the direction of our Division of Health and Safety, and we have expended some $2,700,000 to date in conducting it. We have used the results of these studies to improve the design of new plants and, in some cases, to modify existing plants. In general this has meant increased stack heights in our newer plants to re-

duce the concentrations of stack gases; and the installation of electrostatic precipitators to almost completely eliminate the discharge of fly ash.

Mr. DADDARIO. What stack heights are you talking about in this instance?

Mr. WAGNER. The highest we have built today is 800 feet, Mr. Chairman.

Mr. DADDARIO. Are they any indications that the stacks must be much higher to really answer this problem, or do you feel that the present heights are sufficient?

Mr. WAGNER. I think we are about right. There may be some possibility for higher stacks.

Mr. BELL. May I interject a question, Mr. Chairman?

Mr. DADDARIO. Yes.

Mr. BELL. Would the height of a stack make a difference in Los Angeles?

Mr. WAGNER. Let me say I have with me Dr. Frank Gartrell of our Division of Health and Safety who has been closely associated with this program of air pollution control, and I would like to ask him to respond to that question.

Dr. GARTRELL. With regard to the ultimate height to which stacks might go, I think a lot depends on the particular area in which you might be operating a plant. In some areas you might conceivably go higher than 800 feet where you are in a deep ravine or valley situation. I believe 800 feet is about as high as we would need to go with the powerplants in the Tennessee Valley in dealing with the situations that we have there.

Mr. DADDARIO. Getting back to Mr. Bell's question, could the stacks be built to such a height in Los Angeles that they would be helpful?

Mr. BELL. In Los Angeles there are mountains more than a thousand feet high, right behind the city and winds from the ocean bring the smoke in.

Dr. GARTRELL. I really have not had personal experience with your situation in Los Angeles or the way high stacks perform in that area.

Mr. DADDARIO. But this seems to be a good technique.

Dr. GARTRELL. It serves a very useful purpose, and we are just now getting a body of experience which will allow us to find out how beneficial high stacks in the order of 600 to 800 feet really are in dealing with air pollution problems.

Mr. CONABLE. What is the difference between fly ash and smoke?

Dr. GARTRELL. The usual distinction made between smoke and fly ash is that smoke consists of combustion gases containing appreciable amounts of unburned carbon particles. Fly ash is the solid waste materials in stack gases from furnaces, such as those at modern powerplants, where practically complete combustion of the fuel is obtained.

Mr. CONABLE. They are both tiny particles in the air, aren't they?

Dr. GARTRELL. Yes.

Mr. WAGNER. Between 1953 and 1956, we performed extensive research and built a pilot plant to extract sulfur dioxide, or SO_2, from stack gases, spending nearly $350,000 on this project. But the process was cumbersome and uneconomic and we dropped it.

At the same time, it must be recognized that the discovery and adoption of a process for extracting sulfur from the coal or from

the stack gases is much needed. It would contribute greatly to air pollution abatement all across the Nation; equally significant, it would help to conserve an important but exhaustible natural resource.

Sulfur is basic in the production of fertilizers, and it is becoming important as a plant nutrient. Commercially available sulfur is in short supply, and newcomers in the fertilizer production field are having great difficulty in contracting for adequate amounts of sulfur on a long-term basis.

At a time when we are plagued with world food shortages and when chemical fertilizers can help to alleviate them, there is this added urgency and reason for finding a way to extract sulfur dioxide from stack gases. We are currently assessing present technology in this field and will undertake new research to help find a solution.

I would like to mention also that we are engaged in an extensive clean air program at our chemical fertilizer facility at Muscle Shoals. This facility dates from World War I, with some subsequent improvements. We now have underway a $3 million air pollution control program to bring air quality at the facility up to present-day standards.

As I indicated this morning, here with me are Dr. F. E. Gartrell of our Health and Safety Division and Mr. A. B. Phillips of our Office of Agricultural and Chemical Development. With the committee's permission, I should like to ask Dr. Gartrell to describe in greater detail our study program in air pollution control at our electric generating plants. Then, if the committee has questions about the technical aspects of research in the extraction of sulfur from stack gases, or about the control program at our chemical plant, Mr. Phillips can respond to them.

Mr. DADDARIO. We will proceed with Dr. Gartrell and then see how much time we have.

Mr. WAGNER. Mr. Chairman, you have a copy of Dr. Gartrell's statement. It may take longer to present the entire statement than you desire, and if you prefer, he can give you an abbreviated version of it.

Mr. DADDARIO. Any savings in time will be looked upon favorably.

Mr. WAGNER. Then Dr. Gartrell will give you an abstract.

STATEMENT OF DR. F. E. GARTRELL, ASSISTANT DIRECTOR, DIVISION OF HEALTH AND SAFETY, TENNESSEE VALLEY AUTHORITY

Dr. GARTRELL. The following comments will be an abstract of the more detailed statement.

Prior to the construction of the Johnsonville plant in 1949–53, the only thermal powerplants in the TVA system were relatively small plants which did not present any special air pollution problems. During the past 15 years TVA has added 53 coal-fired, steam-electric generating units to its power production facilities. These units range in size from 125 to 950 megawatts, and are located in 9 plants with total rated plant capacities running from 823 to 1,978 megawatts. The number of units at each plant ranges from 1 to 10.

The addition of 1,150 megawatts now being installed at the two-unit Paradise plant will increase total capacity of that plant to 2,558

megawatts, making it one of the largest plants in the world. TVA powerplants burn about 23 million tons of coal annually. Sulfur in the coal ranges from slightly less than 1 percent to more than 5 percent by weight and averages approximately 3 percent. Ash content varies between 5 and 15 percent.

As planning for the Johnsonville plant advanced, TVA recognized that stack emissions from a plant of the ultimate size contemplated at the site would present a potential air pollution problem. Collectors were available that would provide desired removal of fly ash from stack gases; hence control of particulate emissions did not appear to offer any special problems. However, this was not the case with sulfur dioxide. Because of the many uncertainties at that time in assessing the potential problem in the SO_2 emissions and in planning control measures, TVA initiated a broad-scope air pollution study program. The objectives of the program were to define the problem and investigate practical steps that might be taken if special control measures were indicated.

Principal elements of the air pollution study program are (1) monitoring of SO_2 concentrations in the vicinity of each plant, (2) collection and analysis of on-site meteorological data, (3) biological studies to determine effects of plant emissions on vegetation in special experimental gardens and in surrounding areas, (4) full-scale studies of stack gas dispersion, (5) investigations of possible means for reducing emissions through the modification of plant operations during periods when meteorological conditions are unfavorable for dispersion, and (6) research on processes for removal of SO_2 from stack gases.

Beginning with the Johnsonville plant, preoperational and postoperational air pollution studies have been conducted at each plant. Experience has been used in planning air pollution control at succeeding plants and for additions to existing plants.

Stack performance:

Data obtained from routine monitoring and from full-scale dispersion studies have been utilized in estimating stack height requirements for TVA powerplants. Postoperational monitoring data for each plant have been used to check stack performance and indicated adjustments have been made in stack height calculations for new plants. Until the recent completion of our full-scale dispersion study, principal reliance in stack height calculations was upon formulas derived empirically from monitoring data.

Planning for air pollution control at the Johnsonville plant included computing stack performance by procedures commonly used at the time. Experience after the plant was put into operation was much more favorable than was predicted on the basis of the earlier computations. Even with improvements subsequently made in methods for computing stack performance, as unit sizes and stack heights have increased, experience has continued to be more favorable than predictions based on calculations, though the margin of difference now is much less than it used to be.

A comparison of ground level concentrations of stack gases from the Johnsonville plant with those from Paradise, one of the newer large plants, provides an interesting measure of the progress that has been made in control of air pollution from powerplants by dispersion from high stacks. The original Johnsonville plant was constructed

during the period 1949–53 and consisted of six 112.5-megawatt units with 170-foot stacks, subsequently raised to 270 feet. Continuous monitoring for SO_2 was conducted at locations in the vicinity of the plant where maximum concentrations were expected to occur. From analyses of SO_2 records before the stacks were raised, the maximum 30-minute average concentration of SO_2 was 3.8 parts per million. After the stacks were raised, it was only 0.6 part per million.

The Paradise plant with two 704-megawatt units was placed in commercial operation in 1963. This plant has two 600-foot stacks. Despite the fact that average daily SO_2 emission is double that of the original Johnsonville plant, the maximum 30-minute average concentration of SO_2 recorded thus far by the five-autometer network around the Paradise plant has been 0.4 part per million. In terms of comparison, this represents at least a threefold improvement over the Johnsonville plant, even after the stacks had been raised to 270 feet. A comparison such as this emphasizes the importance of utilizing the best current information in evaluating air pollution potential and in planning air pollution control for large modern powerplants.

Frequency distribution of SO_2 concentrations:

While the maximum ground level concentration of SO_2 that can be expected in the vicinity of a large powerplant is essential to assessment of its air pollution potential, an almost equally important factor is the frequency of occurrence of various ground level concentrations of SO_2 in the area around the plant. Satisfactory methods for calculating frequencies from operational and meteorological data have not yet been devised. However, from analysis of the TVA monitoring data, a certain pattern of frequency distribution has been observed which affords a means for arriving at reasonably good approximations. This has provided a means in cases of limited operational experience for estimating situations beyond the range of actual data, for comparing air pollution experience at different powerplants, and for relating powerplant air pollution potential to air quality standards employing frequency criteria. It has also been useful in showing the difference between pollution patterns of powerplants and those of urban areas with multiple sources of pollution emitted at or near ground level.

The frequency of SO_2 registration at a fixed point in the vicinity of a remote power station is strikingly different from that of a single point in an urban area with multiple sources of SO_2 emitted at or near ground level. The frequency distribution of SO_2 concentrations measured by a recording instrument at a point where maximum concentrations occurred in the vicinity of one of our modern plants with 500-foot stacks was compared with similar data obtained from an air pollution study by the Public Health Service in Nashville, Tenn.

Although estimated SO_2 emissions in the urban area were only approximately half those of the powerplant, the frequency of SO_2 registrations in the urban area (for example at the 0.2 part per million, 30-minute average level) was approximately 35 times that in the powerplant area.

Pollution potential of powerplants under air stagnation conditions:

Air pollution control plans developed for the Kingston steamplant, until recently the largest plant in the TVA system, gave special

attention to a potential problem likely to be associated with periods of atmospheric stagnation. The plant is located in the floor of an Appalachian valley. The local topography is characterized by parallel ridges rising from 400 to 1,000 feet above the valley floor. When meteorological forecasts are for conditions that might result in buildup of pollution levels in the vicinity of the plant, control plans provide for use of low-sulfur coal until the alert period is ended. Also, during such periods supplementary air monitoring is conducted.

While a number of alert periods have occurred since this procedure was initiated in 1954, at no time has significant buildup of pollution occurred.

It appears that for air pollution potential forecasts, powerplants should be viewed as a special case for which the meteorological criteria normally used may not be applicable. For example, general air stagnation conditions prevailed in the Kingston plant area for a 3-day period in the fall of 1964. TVA was alerted by the U.S. Weather Bureau at the beginning of the period and precautionary air pollution control measures were initiated. Autometers were checked at regular intervals. Special helicopter and mobile sampling were conducted during the 3-day period. Frequency and concentrations of SO_2 recorded at ground level were no higher than during normal atmospheric conditions. Under such conditions air pollution does build up in urban areas, as is evidenced by the abnormally high pollution levels which developed in large urban areas during a long period of air stagnation over much of the Eastern United States in November and December 1962.

Operational controls:

The limited special use of low-sulfur coal as mentioned previously is the only operational control that TVA has used so far for air pollution control at its plants. However, there are a number of other potentially useful operational controls which might be used singly or in combination to reduce emissions, enhance dispersion, or both, during periods when ground level concentrations of stack emissions might be expected to exceed desired control levels Among these are load reduction, chemical removal of SO_2 by limestone injection, and raising the temperature of stack gases to increase plume rise. In addition to the obvious operational problems and costs involved in application of measures such as these, there is the problem of forecasting air pollution potential far enough in advance to permit effective application of the controls and accurately enough to limit their use so far as possible to periods when they actually are needed. Intensive dispersion studies at the Paradise plant are expected to lead to better use of meteorological and operational data in predicting significant ground concentrations. In addition, the studies are expected to result in further improvement in formulas for dispersion of emissions from large powerplants.

Research on removal of SO_2 from powerplant stack gases:

As Mr. Wagner mentioned, early in its air pollution studies TVA directed attention to possible processes for removal of SO_2 from powerplant stack gases. TVA's interest in development of a practical process was twofold: for use, if needed, as an air pollution control measure, and also as a possible source of sulfur for fertilizer production and other purposes.

In 1953 TVA initiated research and pilot plant work toward this end at its fertilizer development laboratories.

Research on SO_2 removal was suspended in 1956 when it was concluded that it was highly improbable that a practical process could be developed in any reasonable period of time that might serve as a practicable air pollution control measure or compete successfully with other sources of sulfur. Also, other studies strongly indicated, and experience has confirmed, that satisfactory control for projected additions to the system could be achieved by dispersion from high stacks.

Mr. DADDARIO. Do you think that was a sufficient reason for having discontinued studies—because it could not be competitive? Should we not have continued to try to find a solution to this problem? Mr. Bell raises the question that high stacks may be the answer in some places and not in other areas.

Mr. WAGNER. Mr. Chairman, may I respond to that question?

This particular process that we were working on was dropped. We have not dropped the idea, and as I indicated very briefly and I think Dr. Gartrell will go further, we think research is urgently needed to try to find ways to get this sulfur out, and we are currently assessing the present state of technology, examining what has been done and what is being experimented with around the world. And we plan to get into some new research, but involving different processes.

Mr. DADDARIO. You indicated in your opening statement that this was so, and I did want to wait until the point came up again in the present statement. But it does seem to me that the hiatus is important here. The fact is that you did drop it after all this period of time knowing that it still was a problem and that nothing has been done about it. I wonder if this is wise.

The reason I ask it is that because we have noticed time and time again through these hearings that a problem may be dropped because it is too difficult or expensive.

Mr. WAGNER. This particular process that we tried proved to be not a good one.

Now the problem still needs to be attacked. In the meantime. I should recall that we were working in a period when there really was no information available as to the extent of pollution that you would get from a plant like this, or the effects of it, and we were learning as we went.

We found that the high stacks would for our area and at the present time provide an acceptable sollution. Perhaps we should have pursued other research at that time, but you have to have an idea before you can pursue research, and we are picking that up.

Mr. DADDARIO. I am just trying to find out why expenditures were made on an important project and then stopped. Are you starting again because there is additional interest, because you can get support for it or because you were being criticized for having spent this money without any particular positive results?

Mr. WAGNER. Well, the fact, as I indicated, that sulfur is an exhaustible resource for which there is great use, and it ought to be conserved, has been in the back of our minds. Increases in the use of electricity everywhere also makes it more urgent that the problem be solved now; and there have been advances in technology in various

fields that contribute, we believe, to the better possibility of a solution now.

I am not a technologist, and perhaps I should be letting Dr. Gartrell answer the question, but I did want to make the point that we recognized this was a problem that required solution, and we do as a policy matter intend to do whatever we can about it.

Dr. GARTRELL. Although we suspended actual research in the field, we have maintained our interest in the subject and have kept alert to possible breakthroughs in technology that might provide a practical answer, but the facts in the case were that the power system was expanding rapidly and we needed to have answers at the time, and we realized that the development of practical methods for removal of SO_2 from stack gases was a long-term proposition. And meanwhile, our experience with the higher stacks, as I indicated before, was then and has continued from plant to plant to be very favorable.

Mr. BELL. How much of the sulfur dioxide, which is emitted into the air through the high stacks is washed out of the air and how much of it stays there? Do you have any idea on that?

Dr. GARTRELL. There have been some efforts to try to make an inventory of sulfur compounds in the worldwide atmosphere, and according to the best calculations that we know about there is no indication of any buildup of sulfur compounds or SO_2 in the atmosphere, indicating that the processes for removal are balancing out even the increased emissions.

Mr. BELL. Mr. Chairman, I have another question a little slightly different from this, on the pollution problem.

Some of your plants use coal, and some use oil, or gas. Which fuel represents the largest pollution problem?

Dr. GARTRELL. My experience has been limited to coal-fired powerplants. Gas is a relatively clean fuel. It has the least sulfur in it of any fossil fuel that is available. The sulfur content in oil varies as widely as it does in coal.

Mr. BELL. Yes; I understand that. But I assumed you would use the lightest type that has less sulfur in it.

One other question, Mr. Chairman. I understand you are considering the use of nuclear power in your plants. Is that correct?

Mr. WAGNER. That is correct. We have contracted for a nuclear plant.

Mr. BELL. Does that represent a problem in this area?

Mr. WAGNER. Not a problem in air pollution, no, sir.

Mr. BELL. Would there be a sizable waste problem?

Mr. WAGNER. No waste problems that aren't solvable.

Let me ask you, Frank, to respond further.

Dr. GARTRELL. With regard to nuclear powerplants and the nuclear industry in general, that is one instance in which the technology for handling the waste products, both liquid and atmospheric waste products—that technology was developed concurrently with the development of the basic technology.

The developers recognized that they had a material that had to be handled with great care, so from the very beginning the work in the nuclear field has included attention to problems of waste disposal.

Mr. BELL. Then you would say that more of your plants will be using nuclear energy in the future. Is that what we should look forward to?

Mr. WAGNER. When TVA's decision was made to build a nuclear plant, this was the most economical source of energy available to us and we will continue to analyze the situation when we make each addition to our capacity. I am confident that there will be more nuclear plants built. I don't think that means there will be none of the other kinds built.

Mr. BELL. But this will have some effect on pollution.

Dr. GARTRELL. Our planning with regard to the preoperational and postoperational studies for any effects on the environment will carry through the same regime of study with nuclear powerplants as with coal powerplants. So as time goes on we will have a body of knowledge and experience there to guide us that we can make available to others.

The fact that all of the safety features are there does not mean that we are not going to give as much attention to that facility as we are to others that are burning coal.

Mr. DADDARIO. Let's please proceed with your statement.

Dr. GARTRELL. Some progress is being made and with the worldwide research effort currently being directed to the problem, practical processes for removal of SO_2 from fossil-fuel-fired powerplant stack gases and economic recovery of sulfur for useful purposes probably will be developed. However, at present we know of no generally applicable process that has been sufficiently proved to be relied upon as a primary method of controlling SO_2 air pollution from a large powerplant. Thus, at least for the next few years, SO_2 air pollution control for new fossil-fuel powerplants and additions to existing plants where low sulfur fuels are not reasonably available, will have to be planned with principal reliance upon dispersion from high stacks, with possible supplementary control.

That concludes my statement.

Mr. DADDARIO. We had a very intriguing proposition put before us when Dr. Spilhaus was here. He was the chairman of one of the studies which was made on the subject of pollution. He proposed that we somehow establish an experimental city through which we would try to solve all these problems, not only pollution problems, but also transportation health and education problems. The experimental city would be used as a means to develop new concepts, materials and architecture.

If we were to develop such a city, and the government were to participate and using the technology which exists today, could you supply power under conditions where there would be absolutely no pollution?

Mr. WAGNER. We could supply power so that there would be no appreciable resulting pollution in that city, but we would not supply it from a plant in that city. We don't put our generating plants in cities. When you say absolutely no pollution, you have established a pretty high criterion and I believe Dr. Gartrell would agree that you couldn't fully meet it. For instance, you pollute the atmosphere when you breathe, and so when you say absolutely none, you are setting a very high——

Mr. DADDARIO. Let's qualify it. Considering that we have to breathe, let us take into consideration pollution in the sense of those things that we add to our environment through the process of developing energy, such as the case of TVA.

Mr. WAGNER. I would be interested in taking a flier at that, Mr. Chairman. I think you would have to—well, we have no pollution from our hydro plants, at least virtually none. You may get some ozone created, but I think it would have to be a plant, in the present state of the art that would avoid the use of fossil fuels; is that correct, Frank?

Dr. GARTRELL. Yes.

Mr. WAGNER. I think you would come awfully close to it by using it with a nuclear plant.

Mr. DADDARIO. As I understand it, the principle is that we have the chance to investigate some of these problems as a whole instead of in bits and pieces.

Mr. WAGNER. I would be much interested in taking a flier at that not only from the standpoint of air pollution but from a wider viewpoint which I understand was presented: A city designed for comfortable and pleasant living in a modern industrial society. It is a very challenging idea.

Dr. GARTRELL. One of the more difficult things would be that of handling the solid waste.

Mr. DADDARIO. Dr. Spilhaus included this in his proposal.

Dr. GARTRELL. You would have to have electric automobiles, which we would like.

Mr. VIVIAN. I wonder if I could ask some questions and have the answers submitted for the record.

You refer to a sludge project being administered by the Public Health Service and TVA on page 1 of your testimony, Dr. Gartrell. I wasn't aware that the TVA was engaged in this kind of work, but I would like to have some information on this project.

Mr. WAGNER. We can give you a very brief explanation.

Mr. DADDARIO. Let's have a brief answer and then you can supplement it.

Dr. GARTRELL. This is a full-scale demonstration process for composting municipal refuse and garbage and raw sewage sludge. The plant under construction is being built at Johnson City, Tenn. It is a demonstration project under the new Solid Waste Act that the Public Health Service has responsibility for administering.

Mr. VIVIAN. What is the total cost of that project?

Dr. GARTRELL. We have a rather detailed report on the project with a description of the plan and background, and we will be glad to supply it.

(The report is as follows:)

CONCEPT AND DESIGN OF THE JOINT U.S. PUBLIC HEALTH SERVICE-TENNESSEE VALLEY AUTHORITY COMPOSTING PROJECT, JOHNSON CITY, TENNESSEE

(By John S. Wiley,[1] F. E. Gartrell,[2] and H. Gray Smith[3])

PRESENTED AT THE FIFTH ANNUAL SANITARY AND WATER RESOURCES ENGINEERING CONFERENCE, VANDERBILT UNIVERSITY, NASHVILLE, TENNESSEE, JUNE 3, 1966

About 25 years ago Europeans, led by the Dutch, began development of modern composting plants for the disposal and utilization of urban solid wastes. At first the objective was to produce compost for use as a soil builder or conditioner; later, the objective was primarily to provide a sanitary method of waste disposal

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and secondarily to utilize the resulting compost. While there were many composting processes, two types of plants predominated: the rasping system-windrow composting plants developed by the Dutch N. V. Vuilafvoer Maatschappij (VAM) and the Dano biostabilizer plants developed by the Dano Works in Denmark.

In the United States, Waksman and his associates conducted research during 1926–1941 on aerobic decomposition of plant residues and manures. The first basic studies on aerobic composting of community solid wastes were conducted by the University of California, Sanitary Engineering Research Project (1), during 1950–1952. One conclusion of this work was that composting should be considered as a means of disposal and reclamation for municipal refuse. Gotaats (2) later prepared a comprehensive text on this subject for the World Health Organization.

From 1953 to 1962 Wiley and others (3) (4) of the Public Health Service, Communicable Disease Center, conducted laboratory studies at Savannah, Georgia, and pilot plant studies at Chandler, Arizona. These studies indicated that composting of municipal refuse, with or without sewage sludge, is a feasible and sanitary method of treatment. However, at that time funds were not available for large-scale municipal demonstrations.

At about the same time, Gartrell first proposed a full-scale composting project to be jointly sponsored by the Tennessee Valley Authority, the Public Health Service, and a municipality in the Tennessee Valley area. Both TVA and PHS are interested in sanitary methods of disposal of municipal solid wastes without creating problems of health hazards, nuisance, and water, land, or air pollution. Composting appeared to present a satisfactory method of waste disposal and at the same time to produce a marketable material useful in soil improvement. Marketability of the compost produced greatly affects the economy of a composting operation and may determine whether the process is competitive with other sanitary methods of solid waste disposal.

TVA operates the National Fertilizer Development Center at Muscle Shoals, Alabama, one of the world's largest fertilizer research and development institutions. As a part of its agricultural research and development program, TVA has resources to test and demonstrate the value of compost as a soil amendment and to study marketing opportunities. While the nutrient contents (N, P_2O_5, K_2O) of compost are relatively low, tests may reveal benefits from fortifying compost with nutrients to produce an organic-base fertilizer.

Most American composting plants built in recent years have relied on the sale of compost and salvaged materials for their primary income, while there was only a nominal payment by the municipality for disposal. Wiley and Kochtitzky (5) concluded that the inability to dispose of large quantities of compost at a favorable price was probably a major factor in the closing of six of nine plants during the period 1962–1964. Nevertheless, interest in composting is increasing, and half a dozen plants have recently been completed or are under construction. There will be nine distinct composting processes represented in the fifteen American plants, each undergoing modification and improvement. Reliable cost data are not available, but the industry has found it necessary at the newer plants to increase charges for disposal and to place less reliance on income from sales of compost to meet processing costs.

Processing raw sewage sludge with solid wastes at a composting plant rather than at the sewage treatment plant should greatly improve the economics of composting. Normal sludge digestion and air drying account for an appreciable portion of the cost of wastewater treatment and produce only a low-value product that may contain pathogens and undesirable viable seeds. Since moisture must be added to mixed refuse for optimum composting, sludge can be used to provide moisture along with other benefits. The nutrients in raw sludge will enhance the decomposition of refuse and augment both structure and nutrient content of the compost. However, sludge thickening is required when all sludge and refuse from the same contributory population are combined. There are several relatively inexpensive means of concentrating or dewatering sewage sludge.

In normal composting, the aerobic thermophilic decomposition produces temperatures of 140 degrees F or higher for several hours or even days. Such time-temperature is believed to be adequate to destroy most, if not all, pathogens. Reports by Knoll (6), Wiley (7), and Krige (8) on European and South African studies have consistently indicated the safety of composts produced by a number of processes. Several reports have indicated than anti-microbial substances are produced during composting and that their action may be as important as time-temperature in destroying pathogens. It appears obvious that compost

produced from refuse-sludge mixtures is less apt to contain viable pathogens and seeds than normally digested sewage sludge. However, few studies of these factors have been made in the United States.

PHS is interested in the public health aspects of solid wastes composting and of the use of finished compost in various applications. PHS proposes to study plant operation and sanitation methods to avoid production of odors, propagation of flies and rodents, and disease hazards to the workers and visitors. PHS also will direct studies on the survival of pathogens and indicator organisms throughout the composting and curing periods. This is particularly important when raw sludge is used in the process.

Implementation of the project

During 1960–1964, TVA–PHS conferences were held in Savannah and Atlanta, Georgia; Knoxville, Tennessee; Washington, D.C.; and Muscle Shoals, Alabama. PHS and TVA agreed in August 1964 to undertake a joint research and demonstration project on solid wastes composting. Engineers of TVA, with state and local health department representatives, surveyed refuse and sewage sludge disposal at six cities in the Tennessee Valley area. Agricultural specialists of TVA made surveys of the use of chemical and organic fertilizers in the same six areas. Johnson City, Tennessee, was selected as the preferred site for the proposed research-demonstration composting plant and it agreed to join PHS and TVA in the project.

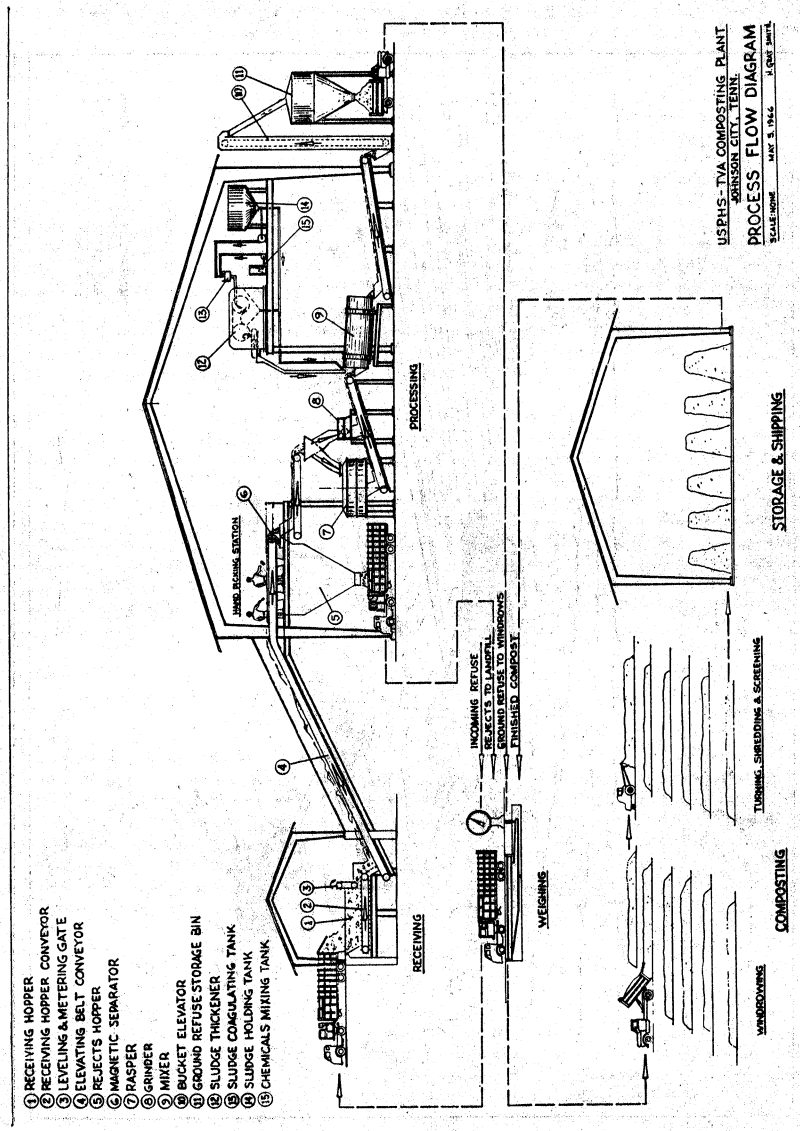
The TVA Division of Agricultural Development initiated a project on "The Use of Municipal and Industrial Organic Wastes in the Production of Soil Amendments and Fertilizers" in March 1963. A continuing study of the disposal of organic municipal and industrial wastes as soil amendments consists of surveys in various sections of the United States to determine the scope and nature of the problem and the current status of research and development in this field. Studies are being conducted on economical means of converting composts into forms suitable for large-scale disposal and to determine the agronomic values of such products. TVA will conduct experiments on the preparation of acceptable composted products, in testing and demonstrating their value and effect, and in determining the market potential for various uses, directed specifically to the operation of the demonstration plant after its completion.

Wiley was transferred in November 1964 to the TVA Division of Health and Safety in Chattanooga to collaborate with TVA in detailed planning of the project. Later, he will move to Johnson City to provide technical guidance in plant operation and to coordinate research activities. A cooperative project agreement on the "Joint U.S. Public Health Service-Tennessee Valley Authority Composting Project, Johnson City, Tennessee," was signed on February 15, 1966, by representatives of the two Federal agencies and Johnson City. Under the agreement TVA will design, construct, and operate the plant with technical guidance from the PHS and will be reimbursed by PHS for expenses of the project. The city will be reimbursed for services and expenses above normal as a result of the operation of the research-demonstration composting project.

Compost plant design

The composting plant will be constructed on a site provided by Johnson City adjacent to its sewage treatment plant. The compost plant will be of the windrow type capable of treating all mixed refuse and raw sewage sludge from the city of 33,000 population. Certain commercial and industrial organic wastes also may be treated. The plant is designed to operate 5½ days a week, single shift, and is expected to process an average of 58.5 tons a day of mixed refuse with a maximum of 70 tons a day and sludge quantities of 9,100–13,200 gallons a day (five percent solids) or 3,800–5,500 pounds a day of dry sludge solids. Refuse processing equipment is designed to handle 10 tons an hour.

The accompanying flow diagram and perspective view show the processing steps and layout of the plant. Refuse will be delivered to the plant in 53-cubic-yard compaction trailers. All incoming refuse, discarded wastes, and compost will be weighed on truck scales adjacent to the office and laboratory building. The receiving hopper has a capacity of about 3,500 cubic feet or about one-half day's collection. A 6-foot-wide plate conveyor, moving about one foot a minute, carries the refuse past a vertical leveler and drops it onto a 3-foot-wide elevating and sorting belt conveyor traveling at right angles to the plate conveyor. The receiving building will be roofed and enclosed on three sides. The belt conveyor will be enclosed between receiving and processing buildings.


① RECEIVING HOPPER
② RECEIVING HOPPER CONVEYOR
③ LEVELING & METTERING GATE
④ ELEVATING BELT CONVEYOR
⑤ REJECTS HOPPER
⑥ MAGNETIC SEPARATOR
⑦ RASPER
⑧ GRINDER
⑨ MIXER
⑩ BUCKET ELEVATOR
⑪ GROUND REFUSE STORAGE BIN
⑫ SLUDGE THICKENER
⑬ SLUDGE COAGULATING TANK
⑭ SLUDGE HOLDING TANK
⑮ CHEMICALS MIXING TANK
HAND RAKING STATION
PROCESSING
RECEIVING
INCOMING REFUSE
REJECTS TO LANDFILL
GROUND REFUSE TO WINDROWS
FINISHED COMPOST
WEIGHING
TURNING, SHREDDING & SCREENING
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USPHS-TVA COMPOSTING PLANT
JOHNSON CITY, TENN.
PROCESS FLOW DIAGRAM
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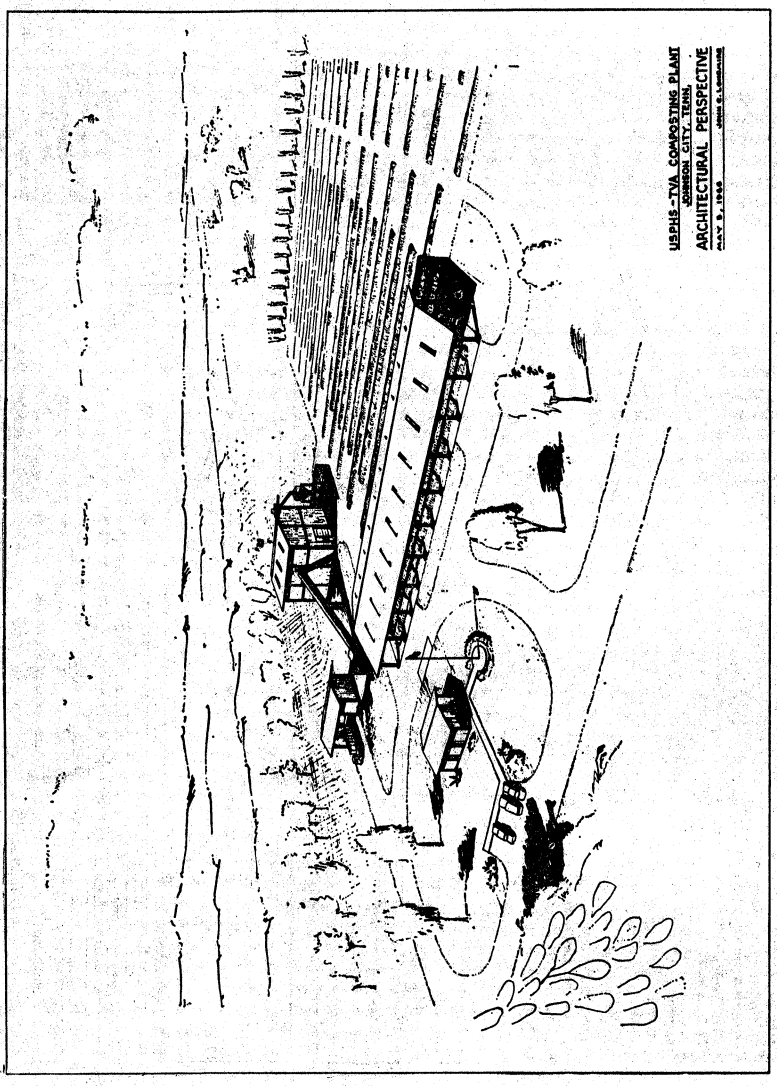
U.S.P.H.S.-TVA COMPOSTING PLANT
JOHNSON CITY, TENN.
ARCHITECTURAL PERSPECTIVE
MAY 9, 1945

The processing buiding will be 40 feet by 60 feet in plan and will house all of the refuse processing operations, the sludge thickener, and the refuse-sludge mixer. Bulky paper, rags, metals, glass, and other noncompostable material, about 25 percent of the incoming refuse, will be removed by hand sorting and magnetic separation and hauled to the Johnson City sanitary landfill for disposal. Two types of grinders, a rasping machine and a hammermill, each with a design capacity of about 8 tons an hour, are so placed that they can be used alternatively for comparison of efficiency and costs of operation and maintenance. The refuse at about 35 percent moisture content, after sorting and grinding, will be mixed with thickened sludge and water as needed to increase moisture to 50–60 percent for the windrow composting.

Initially digested sludge will be pumped from one of the two digesters for thickening and composting with the refuse. As more sludge is removed than received, the digesters gradually will be converted to concentrating tanks until essentially raw sludge is being pumped. Sludge will be thickened in a Permutit DCG Solids Concentrator to a moisture content of about 85–88 percent. Filtrate from the sludge thickener, along with wastewater from the compost plant, will be returned to the sewage treatment plant for processing.

The refuse-sludge mixture will be composted on a 5-acre area graded and stabilized with crushed rock. Windrows, deposited by dump truck, will be about 7 feet wide by 5 feet high and up to 230 feet long.

The active composting time in windrows will be 30–35 days with a maximum of 44 days. During this time the refuse-sludge mixture will be turned 5–10 times with a self-propelled loader. To maintain 50–60 percent moisture content in the composting mixture, water will be added as needed during the turning operation.

It is planned to use a portable shredder and rotary screen unit as the compost is loaded for transfer to the storage shed. The storage shed will be 60 feet by 200 feet in plan and will provide shelter for curing, air drying, and storing the compost. After composting, at least two weeks of curing in windrows will be provided during which the moisture content of the compost is expected to drop to about 25 percent. The estimated average daily production of compost is about 25 tons or 42 percent of the weight of incoming refuse.

Plant operation and research studies

The plant operation will be completely coordinated with municipal activities concerned with refuse collection and disposal and sewage treatment. The city will maintain its present sanitary landfill and sewage sludge treatment facilities for use as needed.

The full-scale plant is planned to demonstrate a windrow method of composting solid wastes which may have application for other communities of possibly 100,000 population or less. One of the objectives of the project is to study the economics of the process. Complete construction and operating cost data will be obtained and economic evaluation of the process will be made. Various methods of "cleaning up" the compost will be tried to remove bits of glass, metal, stones, rubber, leather, plastics, and similar noncompostable materials. Processing methods and duration of composting and curing will be varied with the findings of the two major research studies: pathogen survival in the compost and market uses and value of the product in an effort to speed up decomposition and thus reduce operating costs.

Based on the pilot-plant studies by PHS at Chandler, Arizona, it is expected that 30-day windrow composting will decompose 35–40 percent of the volatile solids. During this time the peak temperature at 10-inch depth in the windrow is expected to be 160–168 degrees F and a temperature of 150 degrees F or more will be maintained for 16 to 22 days. However, temperatures in the outer and bottom layers (possibly 2–4 inches thick) are expected to be less than 140 degrees F most of the time.

Routine analyses will be made on samples of raw wastes and compost for total solids, volatile solids, moisture, and pH. These measurements will serve both in plant control and in plant performance studies. Temperature, moisture, oxygen, and pH measurements will be taken routinely in the composting windrows so that turning schedules and moisture additions may be regulated. Multipoint temperature recording will be employed in an attempt to correlate time-temperature with pathogen destruction.

Certain chemical tests, principally for nitrogen, phosphate, and potash, will be performed periodically to assess the nutrient value of the compost. The value

of high nutrient wastes and of chemical fertilizer materials added to the composting mixture will be determined as they affect both the composting process and the nutrient value of the final compost. Small special windrows of different mixtures of wastes will be prepared and tested in connection with both the pathogen survival studies and the studies on market evaluation of the compost.

To detect and permit the correction of any health or safety hazards or nuisance conditions, close observations of odors, dust, noise, flies, and rodents will be made throughout the plant. The extensive studies of pathogen survival probably will be conducted under a PHS contract with an educational institution starting soon after plant completion next spring. These studies will involve the direct enumeration of those indicator organisms and pathogens normally occurring in refuse and sludge in the raw wastes and after various periods of decomposition in the composting and curing processes. Selected pathogens, not normally occurring in measurable numbers in the raw wastes, will be inserted in the windrows in porous containers for determination of survival rates. Microorganisms will include vegetative and spore-forming bacteria, fungi, protozoa, viruses, and helminths, including some of the most resistant pathogens.

The agronomic studies of compost conducted by TVA will include greenhouse experiments and test demonstrations in plots of the application of compost for various purposes, and the development of marketing potentials for the compost. Tests will be conducted on bare areas such as highway cuts and strip mine spoil banks to assess the value of compost in preventing soil erosion and aiding revegetation on such slopes.

While the principal use of compost is expected to be as a soil builder or conditioner, tests also will be made with compost fortified with nutrients to create an organic-base fertilizer. Large-scale use of compost on farm and pasture land is not anticipated, but appreciable applications on gardens, parks, lawns, golf courses, and truck or specialty farms may be potential outlets. Other uses will be sought, such as compost utilization as poultry litter.

The demonstration composting plant operation is scheduled to continue through fiscal year 1972.

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Mr. VIVIAN. What is the total cost involved?

Dr. GARTRELL. The total cost of the plant is around $750,000 for the initial plant installation. It is being specially designed to meet some research needs so that we can study the effects of the process on pathogenic organisms. It is both a demonstration and a research project.

Mr. VIVIAN. Let me switch to the next question. You indicated that you intend to begin research again. Can you tell me how much money you expect to spend in the next few years?

Mr. WAGNER. There are continuing activities such as Dr. Gartrell has described under the program on which we have spend $2,700,000

to date. What we intend to start up again is an effort to see if we can find a way to get sulfur out of the stack gases that would be a part of the total program. We can supply you our best estimates, although right at the present moment we are assessing the current state of technology and we won't know what kind of projects we want to propose until we get that done.

(The information requested follows:)

TVA is currently spending a total of about $475,000 a year for air pollution control research, and is presently estimating an increase in this level of expenditures to an average of about $675,000 per year over the next several years. A considerable part of this research effort will be directed to the problem of extracting SO_2 from stack gases; and if TVA's research uncovers processes for solving this problem which appear promising, it may want to go into a crash program which will increase the level of its research expenditures in this field substantially.

Mr. VIVIAN. Next question.

When you started this work on air pollution abatement in 1949 as I remember from your testimony, didn't you obtain a great deal of information from others who had built thousands of thousands of megawatts of power installations up to that point?

Dr. GARTRELL. Strangly enough there was very little information available to us. The initial designs of our power stations were based on the best engineering practices at the time. But the thing that brought the air pollution question into focus was the size of the plants that we were expecting to build and the size of the units. The economics of power generation indicated the trend would be toward larger units and more units at individual sites.

So, it was the much greater mass of combustion products that posed the problem.

Mr. VIVIAN. Has the commercial power industry done very much on the subject?

Dr. GARTRELL. Not up to that time.

Mr. VIVIAN. Why did TVA go into this field? Was it because you are in one of the least populous parts of the United States?

Dr. GARTRELL. Because we had an identifiable problem and felt that we should deal with it in the interest of the valley.

Mr. VIVIAN. Suppose the plant that you tried to build had worked successfully. What percentage of the sales cost of power would that have represented? When you amortized that cost through the sale of power, what fraction of the cost would that represent?

Mr. WAGNER. I believe, Mr. Vivian, we did not carry the experiment to that point. We developed the fact that it would be a rather expensive plant, a large plant.

One of the problems was that it would cool the stack gases so much that it would perhaps create an even greater air pollution problem because the stack gases wouldn't rise and the remaining pollutants in them would not be dispersed as effectively in the atmosphere as the hot gases. It was just one of those experiments that was tried, that didn't work, and we didn't carry it to the point of calculating its effect on costs.

Mr. VIVIAN. You could do it with blowers run by additional power. If you were trying to recover sulfur, you might have done it by other means, but I am trying to get some idea of the economics of recovering sulfur in terms of a percentage of the sales cost of electricity.

Mr. WAGNER. It would be rather difficult to get a meaningful figure because this process made a product, not sulfur, but a sulfur-containing product that would have to be marketed, and its marketability and price would depend on how widely the process was applied. If it were quite widely used the larger quantities of material produced would have quite an effect on its market price and upon its cost effects.

Mr. VIVIAN. What I am looking for is any index at all of how much it would cost, in terms of the sale price of electricity, for example in New York, to have the power generating plants in New York which are now on coal, equipped with sulfur-removal equipment. I gather the results of your experience do not tell us very much.

Mr. PHILLIPS. Well, the process we were examining would have been quite expensive.

Mr. VIVIAN. I wonder, Mr. Chairman, if our staff could inquire into that.

Mr. DADDARIO. Yes.

Mr. VIVIAN. You indicated you had burned about 23 million tons of coal a year in your system, with about 3 percent average sulfur content. That's approximately a million tons of sulfur a year going up the stack.

How much does a million tons of sulfur represent in terms of total usage of sulfur per year?

Mr. PHILLIPS. The current production of sulfur in the United States is about 8 million long tons per year.

Mr. VIVIAN. Does the TVA plant system represent 2 percent of the total coal-steam plant capacity in the United States?

Mr. WAGNER. Closer to 10 percent.

Mr. VIVIAN. 10 percent. That's far more than I thought.

Mr. WAGNER. It is close to that.

Mr. BELL. Mr. Wagner, from what I have heard this morning, I believe you could come to the conclusion that we do have some technology to eliminate some of the pollution problems but that many of the methods are so expensive and so difficult that the technology is not being applied as much as possible. Would you agree with that conclusion?

Mr. WAGNER. I think that is not quite correct, but perhaps Dr. Gartrell can answer more precisely.

Dr. GARTRELL. I have recently had occasion to talk with many people doing research on different SO_2 removal processes. There have been many economic studies made and we recently had occasion to review with the Public Health Service the latest developments and different processes under research. The primary purpose of the reviews was to try to see if enough information was available to provide design factors required for building large-scale pilot plants for some of the more promising processes.

Quite surprisingly, the technology for many processes upon which much research has been done is still deficient even for designing a large-scale pilot plant. However, at the present time, several large-scale pilot plants are in various stages of design and construction which will begin to produce soon the kinds of information needed to go to full-scale plant design.

Mr. BELL. Then what you are saying in effect is that we do have to develop some new technology. This is the area we are going to

apply ourselves, develop new technology, and pay the price to get it done.

Mr. WAGNER. Yes; that is correct.

Mr. VIVIAN. Mr. Chairman, I have another question. You indicated that you produce fertilizer in the Muscle Shoals area. Is this fertilizer sold competitively in the open market?

Mr. WAGNER. No; not competitively, sir. The fertilizer that we produce is all used in research and educational demonstration programs. Some of it is sold but it is sold widely across the country and confined by contracts with the fertilizer companies and cooperatives that distribute it to uses which are new, which need promotion according to the views of the agricultural colleges and so on. So we do not regard it as competitive with the fertilizer industry.

Mr. VIVIAN. Does the fertilizer plant itself produce a polluting effluent?

Mr. WAGNER. Mr. Phillips is connected with the operation of that plant. Let me ask him to respond.

Mr. PHILLIPS. It certainly does potentially, and as Mr. Wagner has indicated, we have had quite a program going to solve the problems that we had in the control of this effluent.

Mr. VIVIAN. Do you feel that the effluent produced by this particular plant is comparable with the effluent produced by other commercially owned fertilizer plants?

Mr. PHILLIPS. In some ways it is and in some ways it is not because our particular type of operation there is quite experimental, and also we have some other responsibilities related to national defense which make our operation somewhat different.

Mr. DADDARIO. Dr. Gartrell, in your nuclear plants, have you solved the thermonuclear problems of waste heat that flows into the water?

Dr. GARTRELL. There is more waste heat per kilowatt of generation which has to be dissipated in some way, either discharged into a receiving body of water or handled by cooling towers. We consider this as just another design factor that enters into the design of the condensers and the location of the plant and the provision of adequate cooling water supply.

Mr. DADDARIO. Considering the water into which you can discharge this heat, have you figured out what effect it may have on fish and plant life?

Dr. GARTRELL. We don't anticipate any particular problem at this location. We are aware of the importance of limiting temperatures in streams.

Mr. VIVIAN. Suppose you generated the same amount of power by either nuclear- or coal-fired systems. How much difference would it make in the temperature downstream?

Dr. GARTRELL. We would design the plant in both cases to meet the same temperature control criteria.

Mr. VIVIAN. You say you get the same waste heat for the same amount?

Mr. DADDARIO. No; you dissipate about 50 percent of the fossil fuel heat through the stacks as I understand it; so you are already in a better position with fossil fuels in this particular area.

Dr. GARTRELL. I don't have the exact figures, but it is something in the order of 20 percent more heat which goes to the receiving streams.

Mr. VIVIAN. For which ones?

Dr. GARTRELL. It is more for the nuclear stations.

Mr. WAGNER. The point is that for virtually all of our plants we have our large reservoirs available for cooling. This nuclear plant will be located on the Wheeler Reservoir at a point where it averages a mile or more in width, the depth of the water at the plant site is perhaps 30 feet, so that we will have no problem with heat dissipation. We have one plant where there was not this volume of water available and we are installing cooling towers there. I think Dr. Gartrell's point is that we would design a plant so that the heat dissipation does not constitute a problem. Just as an interesting——

Mr. VIVIAN. You are transferring all the heat to the air somewhere in the vicinity of the plant.

Mr. WAGNER. That is right. The water temperature at any significant distance downstream from our plant is not increased much.

Mr. DADDARIO. I hope that the confidence you have in being able to take care of this problem is going to be evidenced by the complete acceptance by the local community to the idea of putting nuclear heat into the stream, even though you say it is not going to do any harm.

Mr. WAGNER. The local community—and I was there yesterday and spoke to a group—is most enthusiastic about this plant. And, as a matter of fact, the discharges from some of our existing plants are helpful at times. In the wintertime the water in the lakes is quite cold. The fish prefer warmer temperatures than naturally occur so they concentrate around the discharge areas. Fishing there is exceptionally good and the fishermen don't regard that as pollution, I assure you.

Mr. DADDARIO. So, you satisfy the fish population.

Mr. WAGNER. We have, in many instances. As I say, if the dissipation of heat into the stream would be a problem as it will be with the coming unit at our Paradise plant, we would build cooling towers.

Mr. DADDARIO. We have a whole series of questions that we would like to send to you, but I would like to ask Dr. Gartrell a question concerning the connection between meteorology and the emission process in your stacks. You touched on the necessity of improving this technique. How successful have you been in solving the emission problem with present weather information available to you? How would you theorize that such an improved weather reading technique could help in an area such as Los Angeles?

Dr. GARTRELL. Well, of course, in studying any air pollution problem, meteorology is a basic source of information that you have to go to, and for large powerplants you deal principally with what is referred to as micrometeorology, that is, meteorology in the immediate plant area as it affects normal dispersion processes. So, we established at each of our power stations a meteorological station with a tower instrumented to provide continuous records of wind velocity and direction, temperature, et cetera. We routinely analyze collected data along with our SO_2 monitoring data to determine the meteorological regimes under which significant ground level concentrations of SO_2 occur. The fixed station monitoring is supplemented with mobile sampling. We have a specially instrumented helicopter and automobile for this purpose, so for any special meteorological model that

we are interested in we are able to carry intensive sampling. It usually turns out that for a particular plant there is one meteorological model that gives the highest concentration. That's the one that we give the major emphasis in calculating what the maximum concentration is likely to be for the plant and for other plants of similar design and operating conditions. With regard to use of the dispersion equations, the higher the stack, the more data you have to have on wind and temperature conditions aloft. The wind and temperature conditions determine how high the hot gases will rise above the stacks, which is a factor of great importance in dispersion. We have just completed specialized studies on plume rise itself. In summary, basic formulas have long been available that theoretically describe the dispersion process quite well for various conditions, but they contain—as most formulas do—some coefficients that have to be determined with experimental data. Much of our work has been in the realm of taking the theoretical formulas and actually measuring the dispersion that occurs in the atmosphere to develop coefficients required in dispersion computations.

Mr. DADDARIO. As you deveolped your methodology in this instance have you come to the point where you have become confident in its use?

Dr. GARTRELL. Yes. We have great confidence in our computations of what the maximum concentrations are likely to be, but we still haven't figured out a way to compute the frequency with which these various concentrations will occur.

Mr. DADDARIO. How do the private producers feel about this? Do they come to you to ask your advise? Are they working with this same process?

Dr. GARTRELL. Within the past 3 or 4 years we have seen a great interest on the part of the private power companies in doing similar studies of the kind that we are doing. We have made available to them the results of our dispersion and plume rise and other studies. If they are contemplating building a plant of comparable size to one of ours, we have actual data on plume rise and dispersion which they can use. I think, in general, they are approaching the thing in much the same way that we are. Certainly there is a free exchange of information and they know about our dispersion studies and we know what they are doing. All of our dispersion work has been carried out in close collaboration with meteorological groups in other organizations engaged in dispersion studies. The Public Health Service Air Pollution Division has a meteorology research group at the Robert A. Taft Sanitary Engineering Center. Our full-scale dispersion and plume-rise studies are actually cooperative research projects in which that staff participates also.

We feel like we have developed a great body of information that is extremely useful to others as well to ourselves. It is made generally available to any who want to avail themselves of the technology that we have.

Mr. DADDARIO. In talking to people about this as a possible solution to the problem in certain areas of the country, the idea comes up that we can contemplate stacks of much greater height than the ones you have at TVA. Do you have any information about this?

Dr. GARTRELL. No, I really don't. I'm familiar with some figures. As a matter of possible interest to the committee, when our first consultant meteorologist came in and we told him about the size of the plant that we were talking about building he ran through some estimates of how high the stacks should be and gave us some 1,200, 1,500, 1,600 feet heights. As my previous comments have indicated, satisfactory dispersion has been achieved with stacks much lower than these values. Certainly we aren't in a position now to extrapolate beyond where we are to any great extent.

We are just now getting a body of experience with 600-foot stacks and we will soon have some on 800-foot stacks. But, we are seeing that the dispersion patterns are somewhat different for the higher stacks. The maximum concentrations occur under meteorological conditions that are different than for lower stacks. So, 200 feet at a time is about as far as we feel we should go under our conditions.

Mr. BELL. Mr. Chairman, that is about 300 feet higher than the Washington Monument.

Mr. WAGNER. I would just like to add to what Dr. Gartrell has said. We have felt that we had a responsibility to keep the air clean, and he and his people used as indicators of air quality some of the most sensitive plants that we could find in the area. We set for ourselves the goal of being sure that we don't even harm those, and they are much more sensitive than human beings. I think in the long run the answer to pollution problems should be to try to find ways to do something with our wastes other than push them into the air or flow them into our streams.

Mr. DADDARIO. Since the TVA is a Government operation, shouldn't this be the area of an extensive and intensive effort?

Mr. WAGNER. Yes, sir; I think so.

Mr. DADDARIO. We must recognize that the cost for certain of the private utilities is great. If we can develop means to accomplish this end objective in an efficient manner from a cost standpoint, then we could make this information available to industry.

Our goal should be the ultimate removal of all harmful pollution rather than the lessening of its effects in certain scattered areas.

Mr. WAGNER. I agree with that. I think that is consistent with TVA's responsibility—serving as a pilot plant or testing ground for new ideas. It is important in this instance because as I indicated earlier, what happens to air, the quality of the air and the quality of the water in any area has a tremendous effect on that area's capacity for growth and development, and for sustaining the kind of pleasant life that I believe it was Dr. Spilhaus who said we ought to look for; and because of our responsibility for resource development we are interested in this problem of pollution, and I agree with you, Mr. Chairman.

Mr. DADDARIO. When you consider the total capital investment of TVA, the extra expenditures for these purposes would be extremely small, wouldn't they?

Mr. WAGNER. They would be small in relation to the total investment, but I think it is even more significant that the possible successful solution is so important to the Nation as a whole that somebody ought to be working pretty hard at it.

Mr. DADDARIO. Thank you, gentlemen. We appreciate your coming and we will be sending you further questions.

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

Mr. WAGNER. Thank you very much. We will be glad to assist you in any way that we can.

Mr. DADDARIO. Fine.

(The complete prepared statement of Dr. F. E. Gartrell follows:)

PREPARED STATEMENT OF DR. F. E. GARTRELL, ASSISTANT DIRECTOR, DIVISION OF HEALTH AND SAFETY, TENNESSEE VALLEY AUTHORITY

TVA appreciates the opportunity to participate in the hearings of this Subcommittee since we have a great interest in the subject under study—"The Adequacy of Technology for Pollution Abatement." TVA has long been actively concerned with the control of air and water pollution and in recent years has joined the U. S. Public Health Service in a research and demonstration project for treatment and disposal of municipal solid wastes and sewage sludge. Our statement, however, on the basis of discussion with the Subcommittee staff, will be limited to TVA interests and experience in air pollution control—more specifically, control of air pollution from large coal-fired power plants.

Prior to construction of our Johnsonville Plant in 1949–1953, the only thermal power plants in the TVA system were relatively small plants which did not present any special air pollution problems. However, during the past fifteen years TVA has added 53 coal-fired steam-electric generating units to its power production facilities, ranging in size from 125 megawatts to 950 megawatts. These units are located in nine plants with total rated plant capacities which run from 823 megawatts to 1,978 megawatts. Plant and unit data are presented in Table 1.

TABLE 1.—*Major TVA steamplants*

Name	First unit in operation or scheduled	Unit numbers	Rated capacity		Height of stacks (feet)
			Per unit (megawatts)	Total plant (megawatts)	
Bull Run	1966	1	950.0	950	800
Paradise [1]	1963	1–2	704.0	1,408	600
Gallatin	1956	1–2	300.0	1,255	[2] 500
		3–4	327.6		[2] 500
Colbert	1955	1–3	200.0	1,373	300
		4	223.0		300
		5	550.0		500
John Sevier	1955	1	223.0	823	[2] 350
		2–4	200.0		[2] 350
Kingston	1954	1–4	175.0	1,700	250
		5–9	200.0		300
Shawnee	1953	1	150.0	1,675	250
		2–7	175.0		250
		8	150.0		250
		9	175.0		250
		10	150.0		250
Widows Creek	1952	1–2	140.6	1,978	170
		3	150.0		170
		4	140.6		170
		5–6	140.6		270
		7	575.0		500
		8	550.0		500
Johnsonville	1951	1–4	125.0	1,485	270
		5–6	147.0		270
		7–10	173.0		[2] 400
Watts Bar	1942	1–4	60.0	240	150

[1] Unit 3 under construction, 1,150 megawatts.
[2] 1 stack serves 2 units.

NOTE.—In addition to the above-named steamplants, TVA operates under lease arrangement the Thomas H. Allen plant (three 330-megawatt units with three 400-foot stacks) at Memphis, Tenn.

The addition of 1,150 megawatts now being installed at the 2-unit Paradise Plant will increase total capacity of that plant to 2,558 megawatts, making it one of the largest plants in the world. TVA power plants burn about 23 million tons of coal annually. Sulfur in the coal ranges from slightly less than 1% to more than 5% by weight and averages approximately 3%. Ash content varies between 5% and 15%.

As planning for our first major thermal plant at Johnsonville advanced in the early '50s, TVA recognized that stack emissions from a plant of the ultimate size contemplated at the site would present a potential air pollution problem. Collectors were available that would provide desired removal of fly ash from stack gases; hence control of particulate emissions did not appear to offer any special problems. However, this was not the case with sulfur dioxide (SO_2). Because of the many uncertainties at that time in assessing the potential problem in the SO_2 emissions and in planning control measures, TVA in 1951 initiated a broad-scope air pollution study program. The objectives of the program were to reach a better understanding of the problem and to develop practicable steps which might be taken if special control measures were indicated. From 1952 through fiscal year 1966, TVA has expended approximately $2,700,000 on thermal power plant air pollution control studies.

Principal elements of the study program are (1) monitoring of SO_2 concentrations in the vicinity of each plant, (2) collection and analysis of on-site meteorological data, (3) biological studies to determine effects of plant emissions on vegetation in special experimental gardens and in surrounding areas, (4) full-scale studies of stack gas dispersion, (5) investigations of possible means for reducing emissions through modification of plant operations during periods when meteorological conditions are unfavorable for dispersion, and (6) research on processes for removal of SO_2 from stack gases.

Beginning with the Johnsonville Plant, pre- and post-operational air pollution studies have been conducted at each plant. Experience has been used in planning air pollution control at succeeding plants and for additions to existing plants.

PRE-OPERATIONAL STUDIES

Pre-operational studies are conducted to establish baseline information for comparison with data to be obtained after the plant is put into operation and for use in planning post-operational studies. The pre-operational phase covers a period of about two years before plant operation. During this period, on-site meteorological data are collected to supplement regional meteorological data available from U.S. Weather Bureau records; biological surveys are conducted to obtain information on agriculture and forestry in the area; and, as local conditions indicate, dustfall and other air pollution data are collected. The biological surveys include sampling and chemical analysis of selected species of vegetation.

POST-OPERATIONAL STUDIES AND SURVEILLANCE

Post-operational studies include air pollution monitoring in the vicinity of the plant; analysis of data on plant generation and stack emission; analyses of meteorological data and correlation with monitoring data; biological surveys, and special dispersion studies.

For SO_2 monitoring, we have relied principally upon continuous SO_2 analyzer-recorders (Thomas autometer) to provide the desired data. The number of SO_2 recorders used at individual plants has varied from 1 to 11, depending on size of plant, topography, and other factors. Limited use has been made of the so-called sulfur candle or lead peroxide method. Extensive use has been made of mobile sampling equipment utilizing specially instrumental automobile and helicopter. Standard dustfall measurements have been made in the vicinity of the plants by use of dustfall jars. High volume air samplers have been used for measuring suspended particulates.

In planning the biological phases of the studies, TVA drew heavily on the vast amount of information available from consultants and from the technical literature on the effects of SO_2 emissions from smelters on vegetation. By means of special studies using field exposures of specially prepared experimental gardens, and studies using controlled exposure of plants to stack gases as well as to diluted pure SO_2, relative tolerances of native species of vegetation were determined. Species identified as sensitive which occur generally in the area

were selected as indicator plants. Information thus developed was used by the biologists in periodic surveys and special studies of the effect of plant emissions on vegetation. Surveys were supplemented by chemical analyses of foliage to measure any elevation of sulfate which might have occurred.

Soon after our dispersion studies were initiated at the Johnsonville Plant, it became apparent that conventional sampling methods would not be practicable, primarily because of limitations of mobility. To overcome this limitation, TVA developed a technique for use of a helicopter for measuring SO_2 concentrations, both aloft and near ground elevation. The technique was subsequently refined to permit accurate measurements of plume rise above the top of the stacks and of plume SO_2 concentrations and geometry at various distances from the plant. The technique was used in the recently completed TVA-Public Health Service cooperative research project which included a full-scale study of dispersion of power plant gases.

Since the TVA plants generally are located in areas remote from other sources of SO_2, our findings from our air pollution studies should be representative of the stack gas distribution pattern for modern coal-fired power plants. In view of this, a brief review of air pollution experience at TVA power plants as documented by extensive monitoring experience may be of special interest.

STACK PERFORMANCE

Data obtained from routine monitoring and from full-scale dispersion studies have been utilized in estimating stack height requirements for TVA power plants. Post-operational monitoring data for each plant have been used to check stack performance and indicated adjustments have been made in stack height calculations for new plants. Until the recent completion of our full-scale dispersion study, principal reliance in stack height calculations was upon formulas derived empirically from monitoring data.

Dispersion coefficients determined by the TVA full-scale dispersion studies and plume rise data dereived from extensive field measurements have improved our ability to estimate stack performance for large thermal power stations.

Estimated maximum ground level concentration of SO_2 as computed by procedures presently used is not an absolute maximum, but rather a value which TVA experience indicates will not be equaled or exceeded at any one point in the vicinity of the plant (assuming no other SO_2 sources) more than 0.01 percent of the time—that is, approximately two 30-minute periods a year. When exceeded, it would not be by more than 25 to 30 percent.

Planning for air pollution control at the Johnsonville Plant included computing stack performance by procedures commonly used at the time. Experience after the plant was put into operation was much more favorable than was predicted on the basis of the earlier computations. Even with improvements subsequently made in methods for computing stack performance, as unit sizes and stack heights have increased, experience has continued to be more favorable than predictions based on calculations, though the margin of difference now is much less than it used to be.

COMPARISON—GROUND LEVEL CONCENTRATIONS OF STACK GASES FROM SMALL OLD PLANTS AND LARGE NEW PLANTS

A comparison of ground level concentrations of stack gases from the Johnsonville Plant with those from Paradise, one of the newer large plants, provides an interesting measure of the progress that has been made in control of air pollution from power plants by dispersion from high stacks. The original Johnsonville Plant was constructed during the period 1949–1953 and consisted of six 112.5-mw units with 170-foot stacks. SO_2 monitoring was initiated in 1951 when the first units were placed in operation. To overcome downwash due to building turbulence and to improve dispersion, the stacks were subsequently raised to 270 feet. Continuous monitoring for SO_2 was conducted at locations in the vicinity of the plant where maximum concentrations were expected to occur. From analyses of SO_2 records before the stacks were raised, the maximum 30-minute average concentration of SO_2 was 3.8 ppm. After the stacks were raised, it was only 0.6 ppm.

The Paradise Plant with two 704-mw units was placed in commercial operation in 1963. This plant has two 600-foot stacks. Despite the fact that average daily SO_2 emission is double that of the original Johnsonville Plant, the maximum 30-

minute average concentration of SO_2 recorded thus far by the 5-autometer network around the Paradise Plant has been 0.4 ppm. In terms of comparison, this represents at least a threefold improvement over the Johnsonville Plant, even after the stacks at that plant had been raised from 170 to 270 feet. A comparison such as this emphasizes the importance of utilizing the best available and most current information in evaluating air pollution potential and in planning air pollution control for large modern power plants.

FREQUENCY DISTRIBUTION OF SO_2 CONCENTRATIONS

While determinations of the maximum ground level concentration of SO_2 that can be expected in the vicinity of a large power plant is essential to assessment of its air pollution potential, an almost equally important factor is the frequency of occurrence of various ground level concentrations of SO_2 in the area. Satisfactory methods for calculating frequencies from operational and meteorological data have not yet been devised. However, from analysis of the TVA SO_2 monitoring data, a certain pattern of frequency distribution has been observed which affords a means for arriving at reasonably good approximations. This has provided a means in cases of limited operational experience for estimating situations beyond the range of actual data, for comparing air pollution experience at different power plants, and for relating power plant air pollution potential to air quality standards employing frequency criteria. It has also been useful in showing the difference between pollution patterns of power plants and those of urban areas with multiple sources of pollution emitted at or near ground level.

The frequency of SO_2 registration at a fixed point in the vicinity of a remote power station is strikingly different from that of a single point in an urban area with multiple sources of SO_2 emitted at or near ground level. The frequency distribution of SO_2 concentrations measured by a recording instrument at a point where maximum concentrations occurred in the vicinity of one of our modern plants with 500′ stacks was compared with similar data obtained from an air pollution study by the Public Health Service in Nashville, Tennessee. For the period of record at the power plant, approximately 19 months, the highest concentration recorded was 0.6 ppm for three 30-minute periods. SO_2 concentrations were 0.2 ppm or above for only eighty-four 30-minute periods, or approximately 0.40 percent of the time. While the maximum SO_2 concentration recorded in the Nashville study was only approximately 0.3 ppm, SO_2 concentrations were 0.2 ppm or above slightly over 14.1 percent of the time. Estimated total SO_2 emissions in the urban area were approximately half the total emissions of the power plant.

The higher concentrations of pollution in urban areas tend to occur during periods of low wind speed and temperature inversion. In contrast, higher levels from large power plants tend to occur during moderate to high wind and neutral stability conditions. Since none of the TVA plants is located in a large urban area, TVA data do not provide a direct quantitative measure of the contribution of a large power plant to an urban pollution problem. However, analysis of data from a recording instrument located in a small town near one of the large TVA power plants showed that SO_2 in detectable amounts was present 14 percent of the time, but for over 70 percent of the time that SO_2 was present, wind direction was such that stack emissions from the plant could not have been carried to the instrument in town. All the readings, without regard to wind direction, were quite low.

POLLUTION POTENTIAL OF POWER PLANTS UNDER AIR STAGNATION CONDITIONS

Air pollution control plans developed for the Kingston Steam Plant, until recently the largest plant in the TVA system, gave special attention to a potential problem likely to be associated with periods of atmospheric stagnation. The plant is located in the floor of an Appalachian valley. The local topography is characterized by parallel ridges rising from 400 to 1,000 feet above the valley floor. In 1954 arrangements were made for special forecasts for this area by the Knoxville station of the U.S. Weather Bureau during fall when air stagnation conditions are most likely to occur. Since 1960, special national forecasts of air pollution potential by the U.S. Weather Bureau Research Station at the Robert A. Taft Sanitary Engineering Center, Public Health Service, have been available to supplement local forecasts. When forecasts are for conditions that might result in buildup of pollution levels in the vicinity of the plant, control plans

provide for a switch to low-sulfur coal until the alert period is ended. Also, during such periods supplementary air monitoring activities are conducted.

While a number of alert periods have occurred since this procedure was initiated, at no time has significant buildup of pollution occured.

It appears that for air pollution potential forecasts, power plants should be viewed as a special case for which the meteorological criteria normally used may not be applicable. For example, general air stagnation conditions prevailed in the Kingston Plant area for a 3-day period in the fall of 1964. TVA was alerted by the U.S. Weather Bureau at the beginning of the period and precautionary air pollution control measures were initiated. SO_2 autometers were checked at regular intervals. Special helicopter and mobile sample were conducted during the 3-day period. However, as it turned out frequency and concentrations of SO_2 recorded at ground level were no higher than during normal atmospheric conditions. Absence of SO_2 buildup was attributed to penetration of the low-level inversion by the hot stack gases and transport of the plume from the area by light, persistent winds. Under such conditions air pollution does build up in urban areas, as is evidenced by the abnormally high pollution levels which developed in large urban areas during a long period of air stagnation over much of the Eastern United States in November and December 1962.

OPERATIONAL CONTROLS

The limited special use of low-sulfur coal at the Kingston Plant is the only operational control that TVA has used so far for air pollution control at its plants. However, there are a number of other potentially useful operational controls which might be used singly or in combination to reduce emissions, enhance dispersion, or both, during periods when ground level concentrations of stack emissions might be expected to exceed desired control levels. Among these are load reduction, chemical removal of SO_2 by limestone injection, and raising the temperature of stack gases to increase plume rise. In addition to the obvious operational problems and costs involved in application of measures such as these, there is the problem of forecasting air pollution potential far enough in advance to permit effective application of the controls and accurately enough to limit their use so far as possible to periods when they actually are needed. Intensive dispersion studies at the Paradise Plant are expected to lead to better use of meteorological and operational data in predicting significant ground concentrations. In addition, the studies are expected to result in further improvement in formulas for dispersion of emissions from large power plants with high stacks.

RESEARCH ON REMOVAL OF SO_2 FROM POWER PLANT STACK GASES

Early in its air pollution studies TVA directed attention to possible processes for removal of SO_2 from power plant stack gases. TVA's interest in development of a practical process was twofold: for use, if needed, as an air pollution measure, and also as a possible source of sulfur for fertilizer production and other purposes.

In 1953 TVA initiated research and pilot plant work toward this end at its fertilizer development laboratories. The work consisted of the following: (1) an extensive review of the literature and other available information on the recovery of sulfur dioxide, (2) pilot-plant development of an ammonia-scrubbing process for removal of sulfur dioxide from the stack gases, (3) tests of methods for recovering sulfuric acid, ammonium sulfate, and elemental sulfur from the scrubber solution, (4) preparation of investment and operating cost estimates for the process, and (5) small-scale research studies and exploratory pilot plant tests of several alternate methods for removal of sulfur dioxide.

Among the alternate methods of SO_2 removal which we studied were (1) absorption by activated carbon, (2) absorption by a slurry of steam plant ash, (3) vapor phase reaction with ammonia, (4) scrubbing with a suspension of limestone, (5) catalytic oxidation to yield sulfuric acid, (6) catalytic oxidation in the presence of ammonia to yield ammonium sulfate, (7) absorption and oxidation by a slurry of regenerated manganese oxide, with further processing to yield sulfuric acid, (8) absorption by a slurry of rock phosphate to render the phosphate soluble, and (9) injection of pulverized limestone into the exhaust gases.

Research on SO_2 removal was suspended in 1956 when it was concluded that it was highly improbable that a practical process could be developed in any reasonable period of time that might compete successfully with other sources of sulfur. Also, other studies strongly indicated, and experience has confirmed, that satisfactory control for projected additions to the system could be achieved by dispersion from high stacks.

The world sulfur outlook has changed greatly since that time. Today, there is such a sulfur shortage that newcomers to the fertilizer field (which uses 50 percent of all sulfur consumed in the United States) find it impossible to contract for an adequate supply of sulfur. The price of sulfur is increasing rapidly and reserves of elemental sulfur which can be recovered at low cost are decreasing. Further, during the past few years, increased attention, both nationally and internationally, has been directed to reduction in SO_2 emissions from all sources, including large thermal power stations. For these reasons, TVA has renewed its interest in research on processes for removal of SO_2 from power plant stack gases. We have collaborated with the Public Health Service in exploring possibilities for large scale pilot plant testing in TVA power plants of some of the more promising processes in advanced stages of development. We are planning to resume research in this field. We are making an extensive survey of current research on SO_2 removal processes. Results of the survey will be used as a guide in the selection and planning of investigations to be included in the research program.

Some progress is being made and with the worldwide research effort currently being directed to the problem, practical processes for removal of SO_2 from fossil-fuel-fired power plant stack gases and economic recovery of sulfur for useful purposes probably will be developed. However, at present we know of no generally applicable process that has been sufficiently proved to be relied upon as a primary method of SO_2 air pollution control from a large power plant. Thus, at least for the next few years, SO_2 air pollution control for new fossil-fuel power plants and additions to existing plants where low sulfur fuels are not reasonably available, will have to be planned with principal reliance upon dispersion from high stacks, with possible supplementary control.

SUMMARY

We have attempted in this statement to review TVA experience in the measurement and control of air pollution from large coal fired power plants. Progress that has been made in technology for evaluating the potential magnitude of the problem and the demonstrated effectiveness of high stacks for control of air pollution from TVA thermal power plants have been described. We hope that this résumé will be useful to the Subcommittee in its assessment of the technology for control of air pollution from large fossil-fuel-fired power plants.

This committee will adjourn until Wednesday next at 10 o'clock.

(Whereupon, at 12:45 p.m., the subcommittee adjourned until 10 a.m. Wednesday, August 17, 1966.)

THE ADEQUACY OF TECHNOLOGY FOR POLLUTION ABATEMENT

WEDNESDAY, AUGUST 17, 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 10:17 a.m., in room 2325, Rayburn House Office Building, Hon. Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. DADDARIO. This meeting will come to order.

Our witness today is Dr. Abel Wolman, professor emeritus, the Johns Hopkins University.

Will you come forward, please, Dr. Wolman?

Dr. Wolman has been of invaluable assistance to this committee since it began its work on this subject of the adequacy of technology for pollution abatement.

We have consulted with him and so has our Research Management Advisory Panel. We have purposely kept Dr. Wolman until the last day of our hearings so that we might get the benefit of the work he has done during the hearings and so that we might get some interpretation from him of the testimony and projects which have been proposed here.

We are pleased to have you here, Dr. Wolman.

Dr. WOLMAN. Yes, sir.

Mr. DADDARIO. I noticed that during the course of the hearings you were in attendance on several occasions and I appreciate your interest.

STATEMENT OF DR. ABEL WOLMAN, PROFESSOR EMERITUS, THE JOHNS HOPKINS UNIVERSITY

Dr. WOLMAN. Yes. For the benefit of the committee, Mr. Chairman, I have listened to perhaps a third of the testimony and by this morning have read all of it, in fact have read those portions that I had listened to.

I am Abel Wolman, for the record, of Baltimore, Md.

It occurred to me that it might be useful to the committee if I prefaced my summary by a few recordings of past experience in order to indicate to the committee the background which I bring to bear on the conclusions which come out of the hearings.

Although I hesitate to comment on this fact, it has been about 50-some years since I served on the first pollution survey. This was in 1913, and strangely enough it was on the Potomac River, a survey

made at that time by the U.S. Public Health Service. I was a minor laboratory and field worker on that survey.

Mr. CONABLE. Have you noticed much improvement since then, Doctor?

Dr. WOLMAN. Well, I do want to comment later on, Mr. Conable, on very serious evolutions since that time, because as you know there have been a number of surveys since that time, on some of which I have, again, served during the period of years, and perhaps for the rest of my life I may continue to review it periodically.

For a period of about 17 years I was chief engineer of the State Board of Health in Maryland. At one time for about 7 years I was Chairman of the National Board of Water Resources, which some of you may recall in President Roosevelt's period was responsible for most of the Federal water developments in the United States, in irrigation and stream pollution abatement, in power and flood control and the like.

Thereafter, I was chairman of the Maryland State Planning Commission, chairman for about 10 years of the Maryland State Water Resources Commission. I have had the good fortune to act as consultant to the Atomic Energy Commission, the Public Health Service, the Corps of Engineers—well, virtually almost every Federal agency that has some concern with water resources and in general pollution abatement.

I have been and still am consultant to the city of Baltimore, to the Detroit metropolitan area, Seattle, Portland, Oreg., Richmond, the State of New Jersey, the State of Pennsylvania, New York City, for several decades, the Washington metropolitan area, and a series of those.

In addition, I have been in consultation with many foreign countries, on similar sets of problems.

I list these not in order to burden you with them but simply to illustrate that a considerable part of my own life has been spent in connection with the materials and the subjects with which you have been dealing during the past several weeks.

I intend, Mr. Chairman, to divide my comments into two main categories. One is to list for you to the best of my knowledge what appeared to me to be a series of areas of agreement which come out of the hearings. These are some five or six in nature. They establish a setting for the second part of my comments, which will deal with what I call the areas for future exploration.

In the areas of agreement, let me list them very briefly without a tremendous amount of comment.

No. 1. I think it is generally agreed by almost all the witnesses that the public wants clean water, clean air, and clean land.

No. 2 stems from that fact, that when we go to policy and practice, however, we must proceed to translate these absolutes into quantitative goals or objectives, most of which, of course, become relative in nature. They are a natural result in any society where you already have a guide and a precept, but then the problem becomes one of how does one translate those into policy and action.

No. 3. The guiding principles for these objectives covered a very broad spectrum from those who felt that all discharges into water,

into air, and into land, should be zero in extent. In the opposite extreme, suggested by several of the witnesses, these discharges must be the result of wise and logical management of the water, air, and land. In other words, one must use these resources, but with wisdom and with safety.

The evolution which will result I am quite sure, as to which of these extremes will prevail, will probably be somewhere in between. It will be the result of negotiations throughout the United States on all of the governmental levels. Out of these continuing deliberations will come, as has always come, a series of compromises related to money, to functional uses, related to natural resources as they may prevail.

The No. 4 area of agreement, and this I want to stress because it does concern a great many Members of Congress in various capacities: It is quite clear that technology to accomplish many of the objectives, no matter how defined, is available. In other words, the testimony is quite clear that one does not have to stop tomorrow morning and wait for research and development on all fronts. A technology is now available which could be put into play in a series of declining priority. I put the declining priority somewhat in this order.

There is a great deal of technology available which can be continued to be used on the municipal waste level, in discharges into water. It is true that we would continue to search for cheaper, more rapid methods of municipal waste treatment, but one need not delay a great many improvements throughout the United States which can rest on present technology. This technology, incidentally, has had a long evolution which rested on a very sensible set of precepts. The engineers in this field have used natural purification procedures in most artificial treatment plants which happen to be far the cheapest ones we have and which do the job quite well.

When one speaks of extending the degree of treatment of municipal wastes I think we have both the time and the opportunity to explore that in far greater detail. It is not obvious that tertiary treatment of municipal waste is going to be universally necessary or applicable, but if it becomes so it is possible to develop it while we continue current activity.

In second priority, in a declining direction, we know how to do a great many things in the cleaning of air, such as, the removal of particulate matter, the removal of certain other kinds of objectionable materials in the air with present technology. As will appear later, however, there are significant aspects of discharges into the air on which research and technology are seriously lacking.

In still further declining priority we have a vast area of industrial wastes in which solutions are not too obvious or in which solutions are too expensive or in which there is a slow rate of correction.

In other words, in summary with respect to the technology of today, much can be done with what we already know. The rate of correction rests upon the selection of the goal, the purposes for which we want to do it, and it rests, of course, upon dollars, as well as available manpower, although I do not stress this latter too heavily. I think manpower appears as necessity demands. The rate depends also, of course, on the development of institutional structure, largely of regional nature or of river basin areas.

Now let me come to No. 5. A number of significant correctives, however, do wait upon increased knowledge and these will require strenuous research and development on a variety of fronts, in a combination of governmental and private fronts. They will not be resolved to my own mind from the testimony by one or the other, but by both. These do cover, as you will see in a moment, areas of exploration of great significance and should be undertaken as promptly as possible.

No. 6, in the areas of agreement: These hearings essentially are directed to shed light on a simple basic equation which someone has phrased, that if society spends on a program "X" or a series of projects which I call "X" a number of "Z" dollars, will it accomplish the purposes of our objective "Y."

Now, let me go to the areas for exploration. These are not given in any order of priority. All of them lend themselves to available time for exploration. In other words, they cannot be resolved on a crisis basis. And may I add that there is time to do research and development in these areas for exploration. And I list them as I say not in order of any priority.

No. 1 is the behavior of estuaries. That could be on the Delaware, on San Francisco Bay, on the estuary of the Potomac River. The reason many witnesses listed this is that it turns out that our understanding of the biological behavior of estuaries, which will and do now receive the wastes from great metropolitan areas, is not very well understood.

May I illustrate this by reference to one of the few examples which has already been accomplished over the last several years; namely, the study of the Delaware River estuary, costing somewhere between $1 and $2 million. This study was reported upon to the Delaware River Commission about 2 weeks ago. It is the first example that I know of where systems analysis, the use of mathematical models, highly computerized observations, were made over several years in order to determine what effect various policy decisions would have on the behavior and quality of the estuary. In oversimplification, it attempts to answer, and I think does answer very well, what happens if you decide that the estuary should have three parts per million of oxygen instead of four parts per million, or five instead of four parts per million; that is, what are the implications for the rest of the river, implications incidentally which would require a tremendous amount of expenditure. The findings indicate that one may have a choice of expenditures running from $30 to $40 million to something a little short of $500 million, depending upon which parameter or parameters your official agency decides shall control the quality of the estuary.

Now I mention this because this is an example of what remains to be done in a series of estuaries throughout the United States, no two of which probably behave the same way.

Mr. DADDARIO. Dr. Wolman, what is the danger of putting the lower price tag and therefore the lower quality in these proposals as the figure around which public opinion would rally?

Dr. WOLMAN. Well, they do not try to do this. They merely try to answer the question that everyone asks: What are the choices that one would be confronted with, say, in the Delaware estuary if your

policymakers decide that you wanted 6 or 5 or 4 parts per million of dissolved oxygen. Not only do they give you a finding with respect to money that would be involved if you used any of those levels, but they also disclose a number of other choices as to the functions which the Delaware River may perform. And I want to mention that because there is a rather general understanding or assumption that all functions of the Delaware River are compatible with each other. The findings may indicate that there is a degree of incompatibility, and you will have to make choices, somebody will, whether they are made on the Federal level or whether they are made in the river basin authority or whether they are made by the relative States engaged in that particular basin.

This study for the first time as far as I know has used all of the modern tools of systems analysis and models in order to spell out for the policymaker what alternative choices are available.

The study indicates you would want 6 parts per million if you want to support the continuing existence of sport fisheries. As has been pointed out in the testimony here, fish which die on the worst day, even when the average is 4 parts per million, die just the same. It turns out, however, that if you want 6 parts per million at all times for the lowest hour, the lowest day, in the lowest cycle of water hydrology, which may be the lowest in 10 or 20 years, you have to pay not only a dollar price for this but you have to pay a low flow release price for this. The low flow release in this actual example turned out to be somewhere between 10,000 and 11,000 cubic feet per second, which would have to be let down for at least 30 days in order to avoid an instantaneous mortality that might occur under that very unusual circumstance of a dry day or a dry 6 hours.

Now the incompatibility rests on the fact that that is the very time when that large volume of water ought to be retained for the use of the municipal and industrial water supply necessities of that area. These aggregate something of the order of some 16 to 18 million people. In other words you are posed with a realistic choice. Would you choose to release it for the protection of fish for that particular situation. Because it is only in the dry spells that these other alternative uses become dominant. The example of course is quite clear, that this is a source of water you may remember partly for the New York metropolitan area, which services 12 million people, and of course for the whole Philadelphia-Trenton area, which services another 5 to 6 million people.

So, regardless of what your theoretical view might be, the Delaware River Commission at some time or other is going to be confronted with that kind of a choice. This study illuminates the choices. This is the purpose of that 2-year detailed analysis, which I would say is not only an exceedingly unusual one, and we will need more of them, but one which I think is of high technical validity, very competently done.

May I turn to the Potomac and remind you that the Corps of Engineers program on the Potomac with its systems of reservoirs is something of the order of $550 million. About 40 percent of that is necessary or was thought to be necessary in order to provide low-flow augmentation in the Potomac River. That adds up to a great deal of money.

Now, it turns out in the Delaware study that low-flow augmentation for the improvement of the estuary, to the extent of 3,000 or 4,000 cubic feet per second, would have very little value. Yet that is the basis for the designed releases on the Potomac River.

The Potomac estuary at the present has been reviewed at my own university, by a group of oceanographers, biologists, sanitary engineers, and geographers. A report has been made to this area indicating that the understanding of the behavior of the estauary is so poor that it would be very unwise to proceed toward very elaborate low-flow release structures or very elaborate tertiary treatments because it is not at all clear what their impact would be. These investigators have proposed, and this is within this year, after 1 year of inquiry, that a detailed series of studies be made similar to those which were made in the Delaware. This will take 2 or 3 years to do and would require something on the order of $600,000 or $700,000 a year for investigation.

I would add to that, as you probably know, Congress has appropriated something on the order of a little short of $2 million for a similar inquiry on San Francisco Bay, which is even more complicated.

So I list the behavior of estuaries as one of the areas that needs detailed investigation before very large and unusual amounts of money are put into this.

Mr. CONABLE. Dr. Wolman, this is just so we will know what other choices are open in the Potomac estuary.

Dr. WOLMAN. Let us discuss this choice on the Potomac. It has similar implications in all of the other estuaries, such as the San Francisco Bay and the Delaware.

We have all been interested in how to stop the total algae growth, say, in the Potomac. The general assumption so far has been that, if we could remove phosphorus and nitrogen, particularly from the metropolitan complexes, largely municipalities and groups of municipalities, we would not only defer but we would eliminate that problem.

The study discloses that this is not clear and is not guaranteed in any sense. The reason for it is that you may have enough natural phosphorus and nitrogen in all of the estuaries, and you may end up with no particualr improvement from that point of view. And this, of course, is a very important aspect.

Mr. MOSHER. Dr. Wolman, does what you just said apply also to the Lake Erie area?

Dr. WOLMAN. I want to come to Lake Erie as a special problem, because the lakes, again, are different from the estuaries. I do want to comment on that, with some observations which I have been able to make in Europe where lakes are not older geologically but where they have been settled longer than ours.

The fact is that a group representing what I would call a total ecological look at the estuaries has the feeling that we need a great deal more understanding of their behavior. And here I come back to the 1913 survey, curiously enough, on this same river, in which as I say I was engaged as a minor assistant. One would recall, if one rereads that report, that the greatest asset in this area was then considered to be the algae growth on the flats in the vicinity of the Wash-

ington area, as the great purifiers for the discharges of the Washington metropolitan sewage.

Now in that intervening period of a little over a half century, two things have happened. The flats have disappeared because you have done what every growing area has done, that is, you have excavated the flats and made airports and roads and everything else. The flats are now nonexistent, and the algae growths accompanying them have been moved, of course, downstream, through natural and artificial actions.

Now we turn up half a century later and are very much concerned about how to prevent the estuarial growth of algae, their death, their use of oxygen and the consequent destruction of fish.

And there is another aspect of this behavior which turns up in virtually all of the tidal areas. The great problem on the Potomac as you may know, of course, is sediment—that is, suspended matter. The feeling of the group that reviewed this over the last year was that, if you succeed in removing the sediment, and there are certain projects proposed for doing so, you may increase the algae growth rather than decrease it, because you offer a greater opportunity for the penetration of light.

Now these are considerations which, as I say, do not bar you from proceeding technologically in many directions, but there are certain areas which need exploration, and they need them badly before we run too fast and spend too much.

The second, which I will comment on very briefly, is the whole question of combined sewers which has been commented on in the testimony. I think it is salutary that Congress itself has decided to invest now some $20 million in the exploration of this area. From my point of view they did it for very good reasons. The primary reason is that there are alternatives to complete separation of sanitary and storm runoff. The problem is not only money in separation in all the older cities in the United States, because as you know the estimates run anywhere from $20 to $30 billion, although I am not aware where the estimate comes from, though I am aware of the costs in areas such as in the District of Columbia or in the Detroit area.

The Detroit estimate for separation, even if it were physically possible, is about $1¾ billion and that is, $1.75 billion. But the real inquiry that I think HEW and Interior would be now sponsoring is a study of what the alternatives are and how do you reduce the impact of this particular combination of circumstances. And the alternatives are quite a few and they must be explored.

One of the reasons why it is necessary to explore them is that if you were successful in separation completely in the old cities, in separation in all new cities and developments, the accompanying impact on the quality of the receiving bodies of waters through the country as a whole would probably be quite small. In other words, this comes back to the original equation as to whether or not the money would be wisely spent to accomplish a relatively small objective.

No. 3, and again these are not in order of priority: I know the committee was perhaps as impressed and I think in a sense disappointed as I was in the testimony on automobile emissions and the country-wide assumptions and decisions that have been made with respect to

it. I list it here as an area for exploration, because one detects that the ruling or the desire for a universal set of additions to the internal combustion engine would not accomplish the total purpose which all of us have in mind, and that in fact the nitrogen-oxide problem may turn out to be more significant.

I do believe that it is important to call attention again, which is in the record, that I think all agreed, certainly in the southern California area, that the requirement was in the light of present knowledge a wise one. But on the decision that the universalizing of it throughout the whole United States, there is some indication that this requires a great deal more exploration and one which may later indicate that this may not be a wise universal decision.

Aside from automobile emissions, when we come to the general problem of air pollution abatement, the translation of the Los Angeles and southern California experience to the rest of the United States is considered by many workers to be a mistake. The conditions are not comparable and there is no tremendous evidence to indicate that the episodic situation in Los Angeles and obviously the ones in London and in Donora to warrant easy extrapolation to the whole of the United States. We may return to that in a moment.

My No. 4, Mr. Mosher, deals with Lake Erie. One thing is obvious, that Lake Erie is aging. Secondly, there are phenomena associated with that aging that are highly objectionable. A number of correctives, both above Lake Erie and in Erie itself, should be carried forward in the reasonable future and at a rapid pace.

It is also clear, however, that major expenditures—there has been some testimony that it may be something of the order of a billion dollars—need to be spelled out in order that those things that ought to be done should be selectively pulled out of it to be done. Still other proposals should be deferred while research is rapidly pursued in determining what the impact on Lake Erie such measures would have.

Lake Erie has been under a kind of desultory investigation from the standpoint of aging to my knowledge for a little over 100 years. Unfortunately, it has been very sporadic and from a scientific standpoint very limited, although the quality of investigation has been good. But it needs very, very much more elaborate inquiry. The time has arrived, I would say today, where the research aspect ought to be pursued in parallel with a number of the correctives which as I repeat could be carried forward now.

It should be remembered likewise that Lake Erie is the oldest and the shallowest of the series of lakes. It has been aging more rapidly than all the other lakes in that stream.

I might point out that the success, or at least apparent success, of recapturing some of the lakes from increased aging which has happened in Europe, which has had a longer experience with this, has resulted in Lake Zurich primarily and not in Lake Geneva, and in the Bavarian Lakes. But this was accomplished in fact by intercepting all of the industrial and municipal wastes in those areas and taking them completely out of the lake systems and discharging below them.

Now I mention this because such an inquiry in the Lake Erie area is one which obviously you may want to make. I would not dare suggest,

largely because of very limited study of the possibility, whether that has any physical potential. I have not any idea. But I do want to point out that the successful experiences up to the present moment—and they have only been a matter of a few years—of interrupting the aging process has been by interception and by literal physical removal from the area.

In Lake Erie, of course, you are dealing with rather heroic sets of problems. You have the Detroit River coming in which from my own estimate of several years of inquiry is the natural route whereby your treated effluents are bound to continue. Our estimate for 1990 is about 6 million people in the Detroit metropolitan area. And then of course you have the accretions on the lake itself from both sides of the international boundary.

So this kind of a look needs to be taken, not again as a suggestion that you stop improving the quality of the discharges into the lake, but that simultaneously you stop, look, and listen as to your further inquiries and decisions.

Mr. MOSHER. Are you suggesting that we might just take all of this waste, route it around Lake Erie, and put in Lake Ontario?

Mr. CONABLE. No, thank you.

Dr. WOLMAN. You see, what I am saying is that a physical effort of that nature has no counterpart for the moment. It was possible for the sewage and industrial wastes of the Zurich area to be bypassed. Now, of course, it creates a different kind of situation below.

I separated, you may remember, the lakes from the estuaries, for the simple reason that the lakes demonstrate curious biological behaviors. They have the misfortune of not being in tremendous motion. They have some considerable depth, all of them including Erie. You have new water added in very large amounts, but you do not have the kind of continuous flow, even where we run into the tidal situations in the estuaries.

Mr. MOSHER. This would mean, then, that the cycle of changing depths that seems to appear in Lake Erie depends on the amount of water in the lake.

Dr. WOLMAN. Yes.

Mr. MOSHER. It would have a great impact on this situation?

Dr. WOLMAN. Indeed.

Mr. MOSHER. The more water the less——

Mr. CONABLE. The less aging.

Mr. MOSHER. The less aging.

Dr. WOLMAN. And you may have greater "sweeping," if I may use the term.

Mr. MOSHER. Yes.

Dr. WOLMAN. Now the problem of course as you know arises on Lake Michigan, particularly on which the Corps of Engineers at the moment is authorized to engage in detailed studies: You want two things on the lakes and they are two different and perhaps competing things depending on what your hydrologic cycles are. When you are in the dry cycle you want more water.

We have just gone through that in the Great Lakes, all of them, and everybody pleads for doing something upstream where you could release more water.

When you are in the wet cycle, which I have lived through on the Great Lakes, everybody wanted less water because you were flooding out harbors and recreational areas.

The Corps is reviewing this now, for the next 2 to 3 years, to determine how one extricates oneself hydrologically from the dilemmas created by the natural cycles, moving from high floodwater runoffs for a long period of time and then such a period as we have gone through from 1962–65. It is going to be very interesting to see what in general may be suggested.

Mr. MOSHER. I have a constituent who argues that there is a need for much greater control at the point where the water runs out.

Dr. WOLMAN. At the lower ends?

Mr. MOSHER. At the lower end; yes.

Dr. WOLMAN. Now there are differences of opinion where you would do it, whether you would do it upstream or downstream, running all the way from Superior and St. Clair and Erie and down the river.

Mr. MOSHER. Are there studies available on the possibility of controlling the downstream flow?

Dr. WOLMAN. Yes. Now these need to be looked at seriously enough in relation to the problem that we are talking about; namely, of trying to recapture not only Erie but to avoid the degradation of Lake Michigan.

Here again you have competitive forces, and you want to return to Lake Michigan for only a moment. You have the recent Supreme Court hearings—by recent, they have been going on for the last 5 years, and ultimately will reach Congress. But they have a competition which is not easily resolvable, where the people objecting to diversion from Lake Michigan into the Illinois River, want the waste discharges (with treatment) of the Chicago metropolitan area to go back into the lake.

This is interesting, as to that particular group. I am not passing on the relative merits of either, because the case isn't closed yet. But their insistence is that you should not divert that amount of liquid into the Illinois, because it ought to stay in the Michigan.

The people in the Chicago area who oppose this say "Well, now, look, what are you doing, you are going to increase tremendously the aging of Lake Michigan because you will be turning back tremendous amounts of organic materials, tremendous amounts of nitrogen or phosphorus, or you will have to take them all out at tremendous cost."

This issue is one that remains and it is an issue which I do not believe we can escape, no matter what the fiat may be. It will have to be resolved. It is another example where your general total uses have no compatibilities. The decision finally has to be made either by the courts or by your policymakers, either by Congress or by your basin river authorities, as to which one you choose to do. It is not that you choose to degrade it or to lift it up, but you are really making a choice as between functional uses of your water resource. We need to be reminded that those choices are inescapable in a country that is rapidly approaching 200 million people and all the activity that goes with it.

I might say that having the 200 million people is not an unmixed blessing from the standpoint of my professional operations, but they are there, and they do manufacture, and they do produce, and they

do have wastes. As one of your witnesses has pointed out, everything we do results in wastes, everything we do. The trick is going to be in how do we reconcile them, whether in water or air or land. You have already had much testimony to show that the three are materially interrelated. There was no getting around it.

Now, let me just comment on the fifth one, which is the carbon dioxide and greenhouse effect. Without belaboring it, practically every report on air that I have read in the last 10 years refers to the greenhouse effect, generally to the extent of two sentences. When one inquires as to what you are talking about, as you did, Mr. Conable, and what are its implications, you have roughly the kind of reporting that you got out of Dr. McCloud. It is an explanation of what the greenhouse effect is and what its potentials are.

I was glad to see that following that Dr. Malone pointed out that by 1975, with the continuation of present research, you should have some quantitative global picture of the CO_2 issue. But more important than that, you may remember that he said he has a far greater optimistic view about countervailing measures that may be simultaneously instituted so that the concern about CO_2 may be less than the one or two sentences normally disclose.

This is all I want to say on the testimony on the greenhouse effect. It is well to recall that it is under study and that it will disclose what the probabilities will be, but more, it may also disclose what one may be able to do about it.

No. 6: I come to thermal pollution. This is largely pollution coming out of powerplant activities through cooling water, getting into either the water or alternatively into the air. I say alternatively because the conclusion that if you take it out of the water you have disposed of the problem is not true, because then you have a heat problem, if all of them do it, in the atmosphere.

This has been pointed out before at other congressional committee hearings by Dr. Revelle. I merely want to state for the record that again my own institution has been engaged in a countrywide study of thermal pollution, roughly at about $500,000 a year, which we have contracted with the Edison Institute. We have now 15 major powerplants under study throughout the United States on rivers, lakes, and oceans. In order to do what? It is strange at this late date that we must now find out what the physical impact of cooling water discharge is on all of these receiving bodies of water, what their hydrologic behavior is, and what their biological consequences are, all three of which incidentally are unknown at this time. Our Department has selected jointly with the institute some 15 major powerplants.

Now you may have heard in the TVA testimony that thermal discharge is objectionable at some times and valuable at others. The TVA testimony indicated that at some of their thermal discharges fishing was materially improved. This happens to be the case on the thermal discharges on the lower Patuxent, which has just been completed. After 2 years of detailed investigation biologically, it took a great deal of hydrologic adjustment of their discharge and where it is discharged into the river in order to accomplish nonobjectionable results.

This is one of the areas that needs exploration. It is getting it and positive answers in maybe 2 to 4 years should be available for ultimate guides.

Let me call the attention of the committee, however, to another point. It has been said that if we move rapidly into nuclear fission power much of our problems would disappear. This is not so. I simply recall to you that nuclear powerplants must have cooling and we do not dispose of the thermal pollution problem if we move away from fossil fuel power. Nor incidentally do we dispose of any of the waste problems, whether gaseous, liquids, or solids.

The Atomic Energy Commission has done a superb job in restricting the discharges, not eliminating them. Gaseous wastes from nuclear powerplant operations are very, very heavily monitored and very heavily controlled, as are the liquid and the solid wastes. The committee should understand that these are not wasteless operations. They will require a degree of monitoring and supervision which in many respects may be greater than you would have with a fossil fuel burning plant, even though those have difficulties.

Mr. CONABLE. Doctor, why should there be gaseous wastes?

Dr. WOLMAN. There are because they are gaseous productions and they do come out, in minor amount. In the chemical processing of nuclear fuel rods, gaseous wastes are highly important. Low-level liquid waste is monitored very, very carefully from all the existing nuclear powerplants, and as I say, very well managed. But you have them. And you also have, of course, solid waste.

Mr. CONABLE. But gaseous waste is not the result of the thermal conditions?

Dr. WOLMAN. No. They are pickups in a sense in production.

In the processing of nuclear fuel after use—as you know, this is done in centers throughout the United States—it is not being done and probably will not be done for quite some years at the location of power producing units, largely because it is a difficult operation. The wastes from those operations are very high in radiation. The Atomic Energy Commission in this instance has done an exceedingly good job, but by simply holding it. In other words, we know of no disposal or treatment process for the wastes from the chemical processing of nuclear fuel. It is completely unlike any other waste with which we have so far dealt, where time of a very limited nature is on our side. But time is not very useful in the wastes from chemical processing of nuclear fuel because we run in terms of not 30 days or 2 weeks or 6 weeks but in terms of hundreds of years.

Mr. VIVIAN. Are you referring to half-lives?

Dr. WOLMAN. Yes. Much of the plutonium is taken out, which is the longer half-life, but the strontiums and the cesiums persist for a very long time.

Mr. CONABLE. Dr. Wolman, you are suggesting that as we move more into the area of nuclear power, then, we are likely to have a sharply accelerating set of problems there?

Dr. WOLMAN. We have two sets of problems. One is met now essentially by holding. I say essentially, the waste is held at various, not too many, spots, in very carefully monitored tanks, underground, of very special fabrication, with air conditioning in fact, because they are also thermally productive. We hold them. Experimentation is now on in reducing their volume and transferring some of that to salt mines for long-term retention. Salt mines have the merit of being

relatively devoid of moisture, so that the movement of ground water which worried us a good deal, is at a minimum.

We have, however, as your nuclear powerplants expand, an increasing problem with low-level liquids, or we will have, because of the sheer multiplication of their volume. For the moment those are released to the environment with great care, with continuous monitoring, and I would say, from my own point of view, with safety. But they will be multiplied, obviously, manifold. And this poses a problem, again of regulatory management. It is a management issue.

I come to No. 7—I am a little slow in this, Mr. Chairman, but I think the detail is warranted from the testimony.

No. 7 is the disposal of inorganic wastes. This includes inorganic wastes from industry, from the demineralization now being proposed for irrigation waters, from the demineralization of brackish waters, and the byproducts of the desalting of sea water. I put all of these in the total complex of demineralization of the waste resulting from current and emerging processes.

The testimony indicates very clearly, particularly in the case of Mr. Warne from California, that very little is said about this problem, largely because nobody knows what to say about it, because nobody knows where to put it.

If you were to take a brief measurement of the amount of salt to be removed from irrigation water, where you are dealing as you know in tremendous quantities of water, quite unlike anything else that you deal with in municipal waste, you surround yourself with tons and tons—well literally thousands of tons of salt. Then the dilemma becomes one of where do you put it?

The new 150-million-gallon-a-day sea water desalting plant for southern California, which will be removing something of the order of 35,000 parts per million of salt, will result in a massive tonnage of salt thus taken out. Mr. Warne points out, it must then be discharged somewhere, in hot brine. This led him to the suggestion that the amount of research on the coastal behavior of the oceans is almost nil. If we are to proceed with many of these demineralizations, many of which of course ultimately would be on the ocean fronts, we should begin to find out what is to be said or done with these waste products. For example, even the minor salt accumulation in the demineralization of brackish water, by brackish I mean something less than 5,000 parts per million—there are long controversies as to where you put that. Obviously, the State engineers have objected to putting it back into somebody's well, because you are trying to get it out. He does not like you to carry it by pipeline into some surface body of water.

What I am merely recording from the testimony is this emerging issue of tremendous research implications. Bound up with it is detailed inquiry into the whole ecology of the ocean front, where most of these wastes would be likely to find their destination.

Removal of salts from irrigation water which carries a great deal, and incidentally on the Colorado is getting worse year by year—as you go downstream the drainage from the irrigated farm picks up the salts. By the time you get down to Imperial Valley the record indicates clearly an increased concentration of sodium and magnesium chlorides and sulfates.

This salt problem is the concern throughout the world, as Mr. Warne pointed out, in Pakistan and elsewhere. He points out, and I merely confirm the fact, that you have to deal with it.

No. 8 is the removal of sulfur oxides. The dilemma you are in whether you take it out from the stacks or you take it out from the fuels, either from the coal, from the oils, or from the gas. The British at one of their powerplants tried to take it out from the stack by scrubbing. They ended with a dilute sulfuric acid which was worse than what they had before, except that it was in another effluent.

All the testimony indicates that we do not have at the moment a significant economical removal method either from the fuel or from the stack.

One can remove particulate material from stacks and it should be. Such processes are valuable, efficient, and reasonably economical.

I would remind the group I asked Chairman Lilienthal of the Atomic Energy Commission many, many years ago, approximately 15 to 16 years ago, where I was serving then as the Chairman of the Stack Gas Committee of the Atomic Energy Commission, the question which your committee has asked from each witness: What kind of a quantitative standard or criterion should we have for stack gases in all of the AEC operations. He said, "Zero."

Of course, he then hastened to add that this was not only improbable but impossible and, of course, it has turned out to be both improbable and impossible.

What it did do, however—because his request was to keep it down to the absolute minimum—it resulted in an improvement in industrial filtration systems for stack gases of extraordinary character in a period of 2 or 3 years.

But here you had an interesting situation where you had one Federal agency, covering all the plants, whose criterion could control all and which, incidentally, had a great deal of money. But it did result in the fabrication and the development of air-cleaning devices for minute quantities of particulate matter and dissolved matter and very, very small-sized matter which had never been heard of before.

This I think is a significant thing, that if your criterion can be good and can be necessary, you push industrial process developers, as it did in that case, into highly improved technology.

Now, on disposal of solid wastes, I merely want to remind you that one of the very heartening pieces of testimony was the testimony of the Chief of the Bureau of Mines on the potential of the elimination of one of our greatest difficulties; namely, the automobile junkyard. How this will evolve as time goes on and whether these pilot plant operations with low-grade taconite does pan out is still an open question. It was one of the few indications, however, that we would be able to handle the solid-waste problem, particularly on the junk side. And that would cover not only the automobile, but the washing machine, the refrigerator, and all that now is disposed of only by taking it from the consumer when it has been finally made obsolete and giving it to me. I say giving it to me, when I mean depositing it on the shores of Lake Erie or on the estuary of the Hudson or in my parks and the like, and say, "Well, now, you do something with it." More than that is required, of course, as the Bureau of Mines witness indicated.

There is another side of this shield, however, which is a little more attractive. In 30 years the nature of our solid-waste problem has changed, aside from these discarded beer bottles and containers and the like. Our refuse used to be 65 percent organic and 35 percent inorganic—not inorganic, but burnable, combustible material. Today it is the other way around. It is 35 percent organic. This is entirely due to the introduction of refrigeration and packaging. In other words, we do not throw away the food we used to throw away and which was our problem. So there is a good side to this. However, it does make the salvaging of organic material practically unwarranted from an economic standpoint.

The piggeries of Los Angeles, which used to be the largest in the world, went out of business, having been originally paid $3 or $4 a ton for Los Angeles garbage. In the course of time gradually Los Angeles had to pay them, and later they decided to have not much of a piggery, because the supplementary food necessary in addition to garbage was too costly.

Let me go to standards and criteria in the testimony for waste or receiving water and air.

There are two things which appear from the testimony. One, that the official agencies are engaged now under congressional acts in establishing throughout the country over the next year standards for stream quality and ultimately standards for air quality.

This I think wisely is being done on a regional basis, because again there are differences between the rivers, the lakes, and the oceans. And this is being actively pressed with all the States and with the Federal Government.

Standards for wastes themselves or waste discharges generally have not been formulated on any official basis. But since Mr. Vivian has been very much interested in this, it should be pointed out that, first of all, such standards if made would probably be minimum requirements and, secondly, again, ought to be on a geographical or regional basis.

I call his attention to the fact that in the Ohio Valley, through Orsanco they have what they call the four freedoms, rather aptly named. Their standards for discharges are as follows:

Freedom from suspended matter, in order to avoid the sludge deposit:

Freedom from materials which will float; namely, those which give you slick or even uprising sludge deposit;

Freedom from color, and

Freedom from toxic materials.

These are the prevailing four freedoms in the Ohio Valley.

I might say in checking with them yesterday that they feel that a great deal has been accomplished by and with such waste discharge minimum requirements, those which apparently they were successful in selling to industry and municipalities.

Mr. MOSHER. Dr. Wolman, should not you indicate for the record what you are talking about when you say Orsanco? This is an interstate compact?

Dr. WOLMAN. Yes. This is the Ohio River Sanitation Commission and it is a compact group between the States in the whole Ohio River

Basin. It has less powers under congressional sanction than the Delaware River Commission, which has powers of execution, powers of design and construction and finance.

Orsanco has powers primarily of guidance and of advice. The record ought to show that they have accomplished a great deal. Their own feeling is that they have a good deal more to accomplish. They have spent via the municipalities and the industries something of the order of $1 billion in the last 20 years.

As a Federal representative on the original Ohio River Board, which reviewed the whole Ohio River for 3 years, from 1934 to 1937, the terminology we used then has been quoted ever since and erroneously. We described the Ohio River at that time as "an open sewer." And I see that phrase appearing in 1966 newspapers. It is no longer so.

Mr. RYAN. Dr. Wolman, they used that to describe the Hudson at times.

Dr. WOLMAN. It is not true of the Hudson. It is true of parts of the Hudson.

In attending the Delaware River Commission hearing on the estuary research, I read the opening statement in the printed summary. The first sentence stated that "The Delaware was a dirty river." Then the chief engineer of the Commission made his report and indicated that 90 percent of the river is of excellent quality, which I think is true.

Mr. DADDARIO. Mr. Ryan, did you want to follow that up further?

Mr. RYAN. No, I don't want to interrupt further at this point.

Mr. DADDARIO. Mr. Conable.

Mr. CONABLE. I just wondered if you meant to imply that there are no suspended solids going into the Ohio River?

Dr. WOLMAN. No.

Mr. CONABLE. Is that the standard they are seeking?

Dr. WOLMAN. The four freedoms that they seek. I said, and I want to repeat, that they themselves feel that a good deal more needs to be accomplished in order to get these four freedoms, even though as I say about a billion dollars has been spent.

Mr. CONABLE. Well, this would imply secondary treatment at least.

Dr. WOLMAN. Yes.

Mr. CONABLE. In all the cities along the Ohio.

Dr. WOLMAN. Well, it implies secondary treatment certainly on some of them. It implies also a greater degree of industrial action.

Mr. CONABLE. If you had secondary treatment, wouldn't you still be getting 10 percent of the solids dumped into the rivers?

Dr. WOLMAN. Yes, but their effect or their physical impact may not be too important. But it remains to be seen, in turn, whether, say, Cincinnati, for example, would have to go to tertiary treatment.

I said almost at the beginning of this testimony that such decisions will have to be made forever because first of all your total use of the river is increasing.

Mr. CONABLE. A standard adopted by Orsanco must be much more complex than just no suspended solids in the water.

Dr. WOLMAN. Yes. As a matter of fact, I don't want to quote it because I am not sure it is public yet, they have already formulated and forwarded to Interior their proposed standards for the Ohio, in compliance with the Federal act.

Mr. MOSHER. Dr. Wolman, I think we have to recognize that the success of this compact required a great deal of political effort. I happen to have been in the Ohio Senate at the time Ohio ratified this venture and participated in some of the proceedings. It required a lot of effort on the part of various State legislatures to put this together. For many of the regional compacts which we need, we are going to need a similar amount of political effort.

Dr. WOLMAN. Yes. As you know, having been present at the creation of the Ohio compact and having something to do with its formulation and language, we were perfectly aware of the fact that you are dealing with people, you are dealing with money, and you are dealing incidentally with alternative necessities for money.

Of course, it is interesting and striking in this particular documentation—there is no suggestion on the part of any witness that first of all there is a limitation to money and there is no limitation or necessity for public expenditure. This is one of the problems with which we necessarily always have to deal.

We have again in the total field of our society alternative choices to make. I realize that when we go to our own legislature, for example, which is a party to the Potomac compact, which I would say has even less powers than the Ohio, but does a reasonable job. The legislative assembly asks very promptly what are our commitments to it? Usually, of course, there are two: money, and the conversion of their State power to an external agency. Many of them are very jealous of that.

I cannot say much more on the questions of standards and criteria, excepting to say that if I were to take the Lake Erie area one might very well say that you have two things to do, one of which you are already doing under the Federal impact, and that is establish the standards that you want Lake Erie to have as a receiving body of water. The second is to look hard at whether you want to establish minimum requirements for the waste discharges.

I say look hard at it, because I would not be prepared to say that this is what you would promptly want to do, except on a minimum basis. That you may want to do.

The universalizing over the entire country of the same criteria for waste discharge I think would be a mistake, simply because it is a vast country with a variety of situations, natural and man made.

I think it was Mr. Wagner of TVA who pointed out that there is a tremendous difference between what you should do and can do, maintaining high quality, on the Holston, and what you would do on the Mississippi. Two plants in both instances of similar character and of similar production would not be warranted in exercising exactly the same degree of waste control.

There are many reasons why we would be, in fact, making an uneconomic use of the resources of the country. My own inclination is that we use those resources, again, as wisely as we know how, rather than normalizing them.

These efforts to have what was called the postage stamp idea for all criteria is not tenable. There is a difference after all between the deep harbor off of Seattle and the nonexistent harbor off of Spokane. We do not wipe out easily these natural differences by simply saying all of them should be alike.

Mr. DADDARIO. That is included in your prophecy that institutional, sectional, and regional standards will have to be developed.

Dr. WOLMAN. Yes.

Mr. DADDARIO. To take care of this problem.

Dr. WOLMAN. Yes.

Mr. DADDARIO. A standard would apply within these areas rather than cut across all of the sections.

Dr. WOLMAN. Yes. Because I think not only will it be untenable, but it would be unwise. The use of Puget Sound for the docking of the deepest draft ships we have is a reality. Spokane may feel that geographically it has been "gypped," but I know of no way in which one can equalize that.

And yet the feeling that has been expressed by some that all municipal waste, for example, in the United States should have tertiary treatment, I do not believe has either wisdom or logic. The policy should be one of definitive resolving of issues in each case, the Delaware River, Lake Erie, Lake Michigan, and the like.

You may have a series of common objectives in the whole lake system. That may be possible. But I doubt very much whether that system criteria would be the same you would have, say, on the Mississippi, the Missouri, or the Columbia.

A number of other areas of exploration appear in the testimony and I am afraid I shall not be able to cover them, Mr. Chairman. But I do want to add one here which seems to me to be very badly lacking in inquiry. It has been commented on by a number of the witnesses.

It is what I call the environmental determinants of disease. In less fancy phraseology, it directs itself toward the comments made by Dr. Tukey, Dr. MacLeod, Dr. Buckley, and by Colonel Meyer, that so far the impact of environmental insults on man has not demonstrated any very significant deleterious effects.

This statement is somewhat inconsistent with the statements of several of the agency witnesses, who said that illness and death caused by air pollution is one of the great dishonors of this country. I am paraphrasing it.

One must agree that the evidence on this needs to be very heavily explored. Even though there is a bit of an inconsistency, which you called attention to, Mr. Chairman, even in the Tukey report, it still remains a valid statement in their report that this impact, if it exists, is not detectable.

We then come to the question, which I think you also raised, what guarantee does that give us that these insults for the long term may not have secondary and important disease implications? Here research is very, very badly needed, and incidentally very badly neglected.

Mr. DADDARIO. We worry about that conclusion, not so much because the effects can't be determined, but because, as we understand it, no effort has been made to determine them. So the fact that little research has been done in this area is only because the problems are not visible on the surface, and no intensive study has been made to even come to the conclusion that research is necessary.

Dr. WOLMAN. No. I think it is a little better than that, on the present situation. There have been a number of studies made, particularly of the group of respiratory diseases.

Mr. DADDARIO. I am not talking about the effects in all instances.

Dr. WOLMAN. Yes.

Mr. DADDARIO. But in some cases we are just making assumptions and there has been no study whatever made.

Dr. WOLMAN. I think this is true. This is why I stressed the fact that these studies, difficult as they are, should be pursued. Each of your witnesses pointed out that this kind of an epidemiological look is not only time-consuming and expensive, but professionally very difficult to do.

Mr. DADDARIO. But it ought not to be passed over only because it is difficult.

Dr. WOLMAN. No. I say it is an area that needs tremendous emphasis if for no other reason than either you assume that it has no impact or you assume it won't have. Either reason is a valid reason for exploring it.

It is stated, for example, that the rise in emphysema in our country is due to air pollution. However, it is also stated by competent medical profession that their evidence indicates the contrary, that two things have happened, that emphysema has increased tremendously in parallel with increased smoking by women and greatly with men because smoking has not yet been materially reduced.

However, if one talks to the British, as I have again this past June, they feel that emphysema in England is very closely related to air pollution. They point out that people on the Continent, the rest of the industrialized Europe, do not have the same disease situations that London, Birmingham, and Manchester areas have. This disease is known as "the English disease." It does not occur in large numbers anywhere else in Europe.

This is a very interesting thing. It is another example where the extrapolation from London to the rest of the United States or to the rest of Europe may not be warranted. But this is a simple explanation of what I still think needs a very, very detailed look.

The next problem is the question which comes up again and again on systems analysis, models, and computers.

I think, Mr. Vivian, you came in after I had described what I considered to be the first fine study in the Delaware estuary. It was an exemplification of the tremendous value of systems analysis over the last 2 years in the use of mathematical models and, of course, the computerized values that went with it.

It would not have been possible to have disclosed the alternatives presented by these more modern procedures. They were used, at least in this field, extremely carefully and extensively, and incidentally very intelligently.

This provided a policymaking group with almost dozens of answers that you normally would not have been able to do anything more than guess at and probably guess at erroneously. This kind of study needs to be done on a very much wider basis geographically throughout the United States and in many, many directions aside from estuaries. Because we have dozens of choices, this was one of the few times that you could plug them in and really find out what their impact on your answers were to be.

Reuse of waste, which is No. 13. I want to call the committee's attention to the fact that in 1960 there was supplied to the Kerr select

committee, the Senate select committee, a document, incidentally—for which my own associates and I were responsible—on the present and prospective means for improved reuse of water. It is Committee Print No. 30. It has a listing of all the existing reuses and a listing of all the potential ones, and some discussion as to what those potential uses may be.

I call your attention to it because reuse of water is very old. Reuse of waste is quite old. I happen to come from an area in which we have the greatest reuse of sewage treatment effluent in the world, namely at the Bethlehem Steel Co. plant at Sparrows Point. They take the entire sewage from the City of Baltimore for industrial purposes after treatment by the city and by them. It is the largest one in the world. The use last month was about 125 million gallons a day.

Now, one can do this if geographical juxtaposition is favorable. In other words, the Baltimore City treatment plant and the largest integrated steel plant in the world are 26,000 feet apart and two major pipelines connect them. They pay the city for waste water which we were having some difficulty of getting rid of in a little creek.

As I say, this is the largest reuse of water. It is one of many. Whether one reuses waste water or river water or lake water is not that you do it for fun, but it is that you explore whether it is worth your doing it. And this again is not a universally applicable system. It is one which is adapted to the particular and peculiar circumstances of a given situation.

All of these are enumerated in Committee Print No. 30, which was the result again of a request of Senator Kerr.

The question was raised in the testimony, and here too I think we should have some record of it, as to why you cannot do a great many things, say, with municipal sewage, even of a profitable nature. And we have searched for that a great many years.

For simplicity's sake I will simply mention this one fact. It is not the same as being able to manufacture beer or bourbon or the like. Sewage has a peculiar characteristic in modern systems. As we all know, it is a water carriage system. So what we are treating is water which has been sullied by one-tenth of 1 percent of its total. In other words, we are fooling with 99.8 and 99.9 percent water which we brought in in the first place. Using the poetic term we sullied it, and then we turned around and tried to take out of it what we put in. But we are trying to take out one-tenth to two-tenths of 1 percent of something, and this is no mean trick.

We have attempted, for example, to borrow from the brewery industry, how could we sterilize this whole volume, then add a yeast or a bacterial system or something which would do the job more cheaply and more efficiently for us. Of course, such a method would drive us out of the business because we cannot sell a bottle of water for the price of a bottle of beer. It is a cheap commodity.

The committee ought to bear this in mind, that we are dealing with a rather extraordinary complex, due to the tremendous advance made in the sanitation of the world by the water carriage system. This system now turns out to be a plague to us and we will and should put some money into finding out what to do.

I have four or five others, but I shall not give them to you. Your time has disappeared. I do want to be subject to whatever questions you may have that may disclose some of the remaining ones here.

Perhaps I should add the acid mine waste problem. The total problem of mines—the slag pile, the acid mine waste—is where I came in 35 years ago. We sat on a board, a regional board for the coal-producing States, what we now loosely include in Appalachia, and we spent, from memory, about $20 million at that time. We did not succeed and the Bureau of Mines Director pointed out that they have no real solution to acid mine wastes.

Here is an area where deep-seated and prompt research is absolutely essential. We have let it ride for a period of about a third of a century, but there it is, and it never stops.

Mr. DADDARIO. You would not subscribe to the idea that because it has been said that nothing can be done about mine drainage, we ought to consider it to be a natural phenomena and forget about it?

Dr. WOLMAN. No. I do not think it ought to be left that way, because it does do a great deal of damage in many ways.

To be confronted with something unresolved for the rest of our lives does not sit well with me. Research on a multifaceted area needs to be pushed and sponsored. There is no question about it.

Some years ago, a group at the Johns Hopkins University did work on this for 2 or 3 years. It was thought, maybe overoptimistically, that a way of curbing it had been found. This turned out to be a biological phenomenon in the abandoned mines, the unworked mines, and it was approached from that standpoint. It meant in essence that one would have to go back into these mines and paint the exposed walls, which were the sources of sulfuric acid and the like. It never got anywhere.

I have the feeling that it ought to be reopened and other procedures isolated and determined if possible.

Mr. DADDARIO. Dr. Wolman, we don't have much time, but I would like you to touch on a point that we have talked about informally. I do think it is important to have your thoughts on the record.

Related to the question of separating sanitary and storm sewers is the possible expenditure of some twenty-five to thirty billion of dollars to accomplish certain end objectives. What would it and what would it not accomplish? What is your feeling generally about this part of the problem and its relationship to pollution generally? The expenditure on separate sewers is one of the largest put before us.

Mr. MOSHER. Mr. Chairman, he touched on this while you were out.

Mr. DADDARIO. Oh?

Dr. WOLMAN. May I resume it or simply summarize it very briefly?

I am opposed to a heroic expenditure on the assumption, first, that it can be done, but more important that if it were done it would be worth anything like that amount of money from the standpoint of the quality of the receiving body of water.

Now there are alternatives to that kind of a separation, that would cost very much less and which incidentally have already been put into practice in the last 4 or 5 years, at least in the State of Michigan, and probably in several other States.

They require that, if you put in the combined system, storage tanks must be constructed. Every rainfall exceeding the minimum amount

which is built into the system going into the treatment plant, brings the storage tanks into play. They hold those rainwater flood discharges, later releasing them, at a low rate, into the sewer that goes to the treatment plant.

In other words, their assumption is that barring a catastrophic runoff, which the tanks might be too small to retain, you would catch about 85 percent of your normal rains, which normally would have gone overboard into the nearest tributary. With such storage the liquid is ultimately released at a low rate to the treatment plant.

Mr. MOSHER. Where are they doing this?

Dr. WOLMAN. In the State of Michigan. I think their requirement dates back 4 or 5 years, and they have been building them.

I could summarize this very quickly. To get it into your record, by reference to the recent paper by Mr. Reed of the Public Health Service on the very question you raise. The paper spells out, and spells out very maturely, the alternatives to complete separation.

Mr. DADDARIO. I use this only as an example, merely to show that we ought to be thinking about alternate propositions in many instances.

The matter of automobile exhausts and the $50 gadget is an example I think where the public will be expending about half of a billion dollars and no one really knows if the problem will be solved or not. We must also recognize that if the device does not remove all of the effluent, the absolute amount of effluent will eventually increase.

Dr. WOLMAN. Yes.

Mr. DADDARIO. What are your thoughts, Dr. Wolman, about the effects local pollution will have on the entire country? Take, for example, all of the pollution activity in New York City. Doesn't this affect all of us rather than just New York City itself? Shouldn't we be thinking about some proposal which would direct us toward the alleviation of pollution blights of this kind as a general way to get rid of a problem which in fact affects all of us, even though it emanates from one small section of the country?

Dr. WOLMAN. Well, let's first make this comment. New York City has spent until now something of the order of $1 billion on sewage treatment. It has not resolved all of its problems. The estimate on the additional amount that it needs to spend may be something of the order of another half a billion.

It has done a job of protecting a very large series of its recreational areas very successfully. Its beaches have had most of the sewage removed. It has, because it is an old city, in all of its boroughs the combined system. It has therefore begun at considerable expense the actual installation of the tanks that I speak of, because they could not tear up all of Brooklyn, all of the Bronx, and all of Manhattan. I would say it would be physically impossible. They have turned to the alternative of trying to put these floodwater tanks at the terminals of their systems.

Now it would be to the advantage not only of New York but of Chicago, where the conditions are entirely different—it would be to the advantage of all of them if there were improved technology of municipal waste treatment. There is no question about that.

The search for this has not been either too intensive or too revealing. Within reason perhaps the search moved particularly on the Federal

level largely toward determining the merits, the costs, and the methodology of tertiary treatment, which as I said before is not quite what I think the answer will be.

It will be a valuable additional answer where needed, but it does not resolve the central question, because I think one of your witnesses testified that if you subjected all sewages to tertiary treatment it would double to quadruple total cost, in capital, operation, and maintenance. I believe this is so. And I believe you could do it. You could do it today pretty much.

But my own search would be for procedures which are needed in a number of instances that are different from what we now do that are not mere repetitions of our orthodox procedures, and hopefully would be both cheaper and better. On this exploration, we are still fairly short.

Mr. DADDARIO. Mr. Mosher?

Dr. WOLMAN. I do not want to close my own comments without making one general observation on industrial waste, but simply because I would like it in the record.

A great deal has been done with industrial waste. If I were pressed for one sentence of conclusion, however, it would be that I think their pace of correction is too slow. Now my industrial friends would probably shoot me when I leave the room, but I think it is too slow.

I am aware of the reasons why it is possibly too slow. Some restraint is obviously due to obsolete plants, in which the economic cost is high; obviously a dollar spent in process brings a far greater return to industry than a dollar spent on wastes.

My own feeling, my own hope would be, that much of the research in industry would go into in-house process adjustment and not into external treatment. I do not like to be confronted forever with having materials discharged that you have not found a use for and then try to do something with them.

I would even say to industry, as I have, I hope you will aim at a closed cycle.

Mr. DADDARIO. Mr. Mosher?

Mr. MOSHER. No further questions.

Mr. DADDARIO. Mr. Vivian.

Mr. VIVIAN. Mr. Chairman.

I have listened with considerable interest today to the many topics you have covered. I think perhaps I sense a lesser interest in progressing rapidly than I would like.

Dr. WOLMAN. Yes?

Mr. VIVIAN. And I think perhaps my reasons for it are that I think there is a great tendency to let the ocean solve a lot of problems. I am not at all sure that this is any wiser than the attitude we had a hundred years ago when we said let the streams solve the problems, or 50 years ago when we said—for example, in my own area, let Lake Erie solve the problems.

My reaction tends to be that I would dispute with you the many comments you have made that we need to slow down, that we need to lean back.

Dr. WOLMAN. May I interrupt, Mr. Vivian?

Mr. VIVIAN. Yes.

Dr. WOLMAN. You came in after I said we need not slow down, after I pointed out explicitly——

Mr. VIVIAN. It was probably well I came in after that point, because from listening to the details I concluded you meant that.

Dr. WOLMAN. No, I think you did me an injustice.

Mr. VIVIAN. I will be glad to correct that.

Dr. WOLMAN. I feel that is important, because I stated in my memorandums on "areas of agreement" that come out of the testimony that there is no reason to stop correctives because of nonexistent technology. We have enough existing technology to proceed apace.

Then your witnesses proceeded to carve out—and this is the part that you got—carve out the "areas of exploration." But my first statement, and I think the chairman would bear me out, was an insistence on the fact that absence of technology need not stop our operations.

Mr. DADDARIO. I have a quote from you, where you say "So we need not stop." That was your earlier statement.

Dr. WOLMAN. I think, Mr. Vivian, it is important that I try to adjust, because what I was talking about when you came in was truly areas—what I would describe—of relative ignorance, and these ought to be clarified, investigated and stopped. And obviously you might then get the impression, I am quite sure, that, I was saying we do not know this and we do not know that. These statements cannot be separated from what I said we did know.

Mr. DADDARIO. It might be helpful if Mr. Vivian would take an example or two where he believes we should be going ahead further and see what you think about it.

Dr. WOLMAN. All right. Yes.

Mr. VIVIAN. All right.

You mentioned quite a number of areas. For example, you mentioned the subject of power technology, generation of power from atomic energy, and you quoted a number of problems which you felt would impede the progress in this area. However, whatever those problems may be, there is no evidence that I know of that they will be any worse than the present problems. In fact, they will be less troublesome than the problem of commercial or conventional fossil fuel technologies. These are in trouble for two or three reasons, one of which is pollution, another of which is resources, and the third of which is international distribution of resources.

Dr. WOLMAN. Yes.

Mr. VIVIAN. I realized that you would not be appreciative of my comment. The reason for my making it is that I think it is important we make it clear that when the issue lies between holding back and going ahead we should go ahead. I think experience shows that very few pollution abatement systems or processes have exceeded their need, just as very few highways have exceeded their need over the past generation. We are growing so rapidly in both population and technology that what we once thought were the marginal problems become the central problems and what we thought were the far-out problems became the day-by-day problems. I am quite concerned about slowing down.

I wish to shift to a completely different subject area. This being the conclusion of the present series of hearings, it seems to me that

an essential step at this point is to ask the old simple questions of what, when, why, how, who and where, as regards progress in this field.

For example, many particular problems have been brought up in water pollution, in air pollution, in solids pollution, in thermal pollution, in radioactivity pollution, or in noise pollution—and I am sure I have left off a few. What I don't see in this whole sequence, and this is in no way a reflection on yourself, sir, is an understanding of how our own Government is progressing in an organized way to attack at least the technological basis of the problem.

Now, for example, there is in the Department of Interior today the Water Pollution Control Administration.

Dr. WOLMAN. Yes.

Mr. VIVIAN. I am certain it doesn't cover all aspects of water pollution control. For example, I doubt that it covers thermal pollution of waters.

Dr. WOLMAN. I would suspect that it could.

Mr. VIVIAN. It could, but I bet it doesn't.

Dr. WOLMAN. I say I would suspect it could.

Mr. VIVIAN. Yes. Then, for example, on air pollution control, I believe that activity remains in Health, Education, and Welfare.

Dr. WOLMAN. Yes.

Mr. VIVIAN. And on solids, disposal of solids, there is a group in——

Dr. WOLMAN. HEW.

Mr. VIVIAN. In HEW, but there also happens to be the mine waste problem, which is half solid and half liquid. I am not quite sure where that lies in relationship to the Department of Interior's water pollution and/or HEW's air pollution and solids pollution activities.

Mr. DADDARIO. If the gentleman would yield for a moment.

Mr. VIVIAN. Yes.

Mr. DADDARIO. Part of the staff activity which is going on is an investigation into each of these departments so that part of our record will show where everything is. We will be able to find out what they are doing and perhaps how each of them could be expanded.

Mr. VIVIAN. This is the nature of my present concern: As the problem has grown in consequence, which it certainly has, and as it has grown in expense, which it certainly has, responsibility is shifting slowly from a local area handled by local contractors with local officials, to one in which the States play a role. But the States' resources are inadequate and the Federal Government is now playing a much more important role. Regional organizations are playing a role, but the need for the Federal Government to handle the problem by itself has increased.

It would seem to me that one of the concerns that we need to pay attention to is which of the specific problems that we have run across need attention and what is being done to solve them. Second, what kind of time schedule can we set for each one of these specifics, and why have we set these goals? Beyond that we will very quickly come to the questions of how and who and where, and we will immediately come back to the Federal Government. We may need some recommendations as to how and why these different organizations tie together, and what goals and guidelines should be set for them to live by. I am particularly concerned because I don't think any of these orga-

nizations are concerned with the pollution of the sea. I am not aware of any one of them which pays any significant attention to the pollution of the sea.

Dr. WOLMAN. There is a new one just created, that is your Oceanographic Council. And I would like to comment not only on it, Mr. Vivian. My Nos. 15 and 16 in "areas for exploration," where I was the victim of time and I did not reach—No. 15 was interagency communication and coordination, and 16 may surprise you, was communication and coordination on the congressional level, which I would incidentally rate as of high importance. And I hope you will forgive me for mentioning it. But I did want to point out in interagency operations that we have a whole series of recently created councils. We have the Federal Council on Water. We have the OST Office, which is supposed to keep an eye on the total research operations and perhaps even have some suggestion as to where it ought to be allocated and, incidentally, how much and how fast. We have the new Oceanographic Council, which I understand has just been created and will be in operation.

As a long participant in governmental actions, even on the Federal level, I gave up long ago, Mr. Vivian, ever hoping that we were going to have a simplified structure in the Federal operation. So what I do as an individual is try to design and strengthen the lines of communication, which I know is in your own mind. But I do not know of any substitute for it, because we have myriads of agencies to struggle with, sometimes on the same subjects as you point out. When I listed Nos. 15 and 16, I would make a plea that somewhere or other we have some kind of meshing. I am not so much interested in eliminating competition in research, because I think there are values in that, but I do wish that we could keep them from falling over each other and also from seeing that some of these necessities do not fall in between the cracks and nobody does them.

Mr. VIVIAN. Can I ask you if the Oceanographic Council intends to look into the subject of pollution of sea? Is that a major interest of the Council?

Dr. WOLMAN. I would say offhand that it probably was not, and I will do my part to see that it becomes so, because I rate it very high.

The reason I say it probably does not, I would simply recall to you that in the earlier work in Los Angeles and New York City the whole tremendous problem of sewage disposal, in which as you know millions and millions of dollars were spent for correction, the amount of money spent initially on oceanographic inquiry I think was much less than $100,000. The amount of money spent on corrections, which, incidentally, have since been modified and spent again, was of course running into the tens of millions of dollars. And oceanographers themselves were critical of the fact that you were going out into the ocean without any understanding of the ocean behavior. A good deal of that is being corrected, but not enough.

Mr. VIVIAN. Mr. Chairman, I would agree with a number of the comments made a few moments ago by Dr. Wolman. He brought up the point of congressional committee coordination which I myself find to be an exasperating subject. I think because there is no clear-cut place in the administration that I personally could find, which shows

any broad scope interest in polluting control, this perhaps is a place where the Congress through this committee could make a more aggressive attack than is possible within the administration at this moment. For that reason, I would suggest to the chairman, as I have previously, that, in addition to using its own staff resources and in addition to using individual consultants who are acquired for specific guidance, this committee might desire to initiate study contracts with some major research firms in the Nation for the purpose of coming up with comprehensive and detailed reports on a great many topics.

I know the chairman has given some thought to that matter and I do not ask him for any opinion at this time, but I would like to pose this for the benefit of my other colleagues who are present.

Mr. DADDARIO. You know that I am favorably inclined toward the suggestion that you have made, Mr. Vivian. I think it has a great deal of merit and certainly will be considered as we begin putting the mass of this information together. From the standpoint of the congressional interaction, this committee has for a time directed some of our efforts toward advising the committees which have operational authority, and they have followed our advice. So we have done really what you have said—we have strengthened lines of communication. That seems to me to be a favorable development and one which we will keep in mind as we begin making recommendations in our report.

Mr. Conable?

Mr. CONABLE. Mr. Chairman, I don't have any questions for Dr. Wolman, but I would like to say to him that I think he has given us a very illuminating morning. We have every reason for gratitude for not only your having been here this morning but also for your having been able to comment on the testimony of many of the other witnesses who appeared before this committee. I think your testimony has been an extremely valuable addition, not only of our own knowledge but also of your thoughts on the points that have been expressed by these other men.

Mr. Chairman, I would like to ask now where we go from here. We presumably will have a report which I trust will draw together much of this testimony as Dr. Wolman has done. This will be used as a piece of source material for the Congress—part of the process Mr. Vivian was talking about.

I am wondering what our plans are for the immediate future, this being the last day of the hearing?

Mr. DADDARIO. Even though this is the last day of these hearings, it does not mean that we are not going to continue taking testimony. Many people are continuing to show an interest and we will allow them the opportunity of submitting information for the record. We have numerous questions going out to witnesses who have appeared and to others who wish to participate in this way. We must hear from the agencies. This committee will not recess permanently when we recess today, but will be meeting again when new information is received in the weeks ahead.

Mr. MOSHER. Do you have any date as a target date for a report?

Mr. DADDARIO. We would have hope that we could have this done by December 1.

Mr. MOSHER. December 1.

Mr. DADDARIO. December 1 is the target date I had in mind, Mr. Mosher, but one which will necessarily be flexible in the event we find the task so great that we can't put it together in this period.

The fact that we have closed our formal hearings here does not mean that we do not intend to take further information and to follow some of the channels which have opened up to us. I think there is a mass of material to be gathered and a number of unusual opportunities for this committee to make a positive contribution in this whole area.

Mr. CONABLE. Are you planning, Mr. Chairman, to have any executive sessions of the committee and meetings with the staff to discuss the hearings while they are still fresh in our minds and perhaps to chart future events, or do you think we should wait for the report?

Mr. DADDARIO. Oh no. We will be having executive sessions. We will be sitting down with the staff and with some consultants as we get the pieces and the parts of the information together. It will entail considerable activity and work on the part of the committee.

I would like to have unanimous consent from the committee that the report on pollution which Dr. Wolman previously made for the Research Management Advisory Panel of this committee be placed in the record following Dr. Wolman's testimony this morning. If there is no objection, it shall be done.

(The document referred to follows:)

REPORT ON POLLUTION

TO

THE RESEARCH MANAGEMENT ADVISORY PANEL

OF THE

COMMITTEE ON SCIENCE AND ASTRONAUTICS U.S. HOUSE OF REPRESENTATIVES

BY DR. ABEL WOLMAN

THE JOHNS HOPKINS UNIVERSITY

General Summary

A review of the present status of water, air, and land pollution and proposals for abatement thereof makes reasonably clear that corrective legislation has quite well outrun both factual bases for action and smooth machinery for development and regulation. One need not belabor the interesting question as to how these "crisis" laws appeared so prolifically, except to note that they were presumably sparked by sudden awakenings of social consciousness.

As time passes, the health implications of many of the underlying justifications for speedy action will become clearer. It is evident, however, that some exaggerations in this area will be dampened. That society wishes cleaner water, air, and soil is abundantly clear. Whether it is willing and able to pay for them remains to be demonstrated.

Throughout the inquiry, it is manifest that the objectives need to be defined, if only in general terms, in legislative directives and in administrative rule. The wide spectrum of ultimate purposes now prevailing provides little guidance and much confusion.

A more specific and less propagandistic factual basis should be developed for abatement guidance. The blanket tabulations now in print are designed for gross alarm rather than for detailed isolation of problem. We are badly in need of information on the present condition of water, air, and land—as base lines for intelligent action in the future.

In the field of economics, information on local capacity to pay is singularly deficient. It may be universally true that, as one observer puts it: "the problems are in the municipalities and the money is in Washington." The documentation on this presumed axiom is missing.

With the growth of Federal grants-in-aid, in this field alone, over 30 were operative in 1965. A search for alternatives to these prolifera-

tions via a blanket tax return to State and local governments or some other simple device may reduce rising Federal administrative costs and complicated grant machinery.

The participation by private industry in research, development, and correction is very limited and too frequently ignored. This deficiency needs careful review, since many of the problems and the solutions have their origin in industrial practice.

An assessment is needed of the present state of science and technology in the abatement field. What and where have the research grants-in-aid produced fruitful results? An analysis of the experience to date, difficult and hazardous as this may be, should be periodically explored. Great special problems remain to be resolved, e.g., behavior of estuaries and rivers, eutrophication of lakes, storm water discharges, agricultural land runoff, stack gas dispersion, SO_2 removal, and CO_2 cumulative effects.

It is not surprising that, in the desire to accomplish multiple results in such varied activities as air, water, and land pollution, coordination should be deficient on both the legislative and executive levels. It is not presumptious to suggest that in this category of action, real values of interrelationship might be discovered and implemented.

At the risk of undue reiteration, the following brief suggestions for consideration are specifically noted:

Legislative

Seek policy clarification on goal of pollution-control endeavors.

Foster establishment of such instrumentalities as conservancy districts and watershed authorities for designing, financing, and operating regional quality-management programs—include financial incentives toward this end.

Invite consideration of extending the corporation tax investment-credit privilege (now 7 percent applicable to expenditures for production facilities) to stimulate waste-control installations with credit rates up to 30 percent for this type of investment.

Administrative

Explore means for relieving tensions in relationships with the States, particularly by substituting consultation conferences for present adversary-type proceedings.

Assign by contract with the U.S. Geological Survey the task of monitoring quality conditions and thus be armed with independent assessment of situations that may lay claim for enforcement actions.

Review justification for long-term, multimillion dollar comprehensive basin studies of pollution and examine alternative procedures for prompt identification of problem areas and planning of corrective measure.

Institute, in collaboration with States, periodic aerial and boat surveillance of selected areas to expedite detection and correction of visual evidences of pollution.

Create procedures for handling citizen complaints that would relay such reports to States, request reply on action taken or contemplated, advise complainant of referral to State agencies, and provide follow through on disposition of matter.

Fiscal

Determine if congressional appropriations for municipal sewage-plant construction are realistically geared to achievement of national

aspirations. Analyze inequities in present methods of State allocations.

Seek an increase in grants to States for enhancing their administrative capabilities, with the proviso that the States must increase their appropriations to be eligible for such aid.

Research and development

Assess relative effectiveness of intramural and extramural research programs as a basis for realinement of future budget allocations.

Emphasize research on physiological aspects of water and air quality with respect to man.

Evaluate productivity of research grants awarded to academic institutions, to industry contractors, and other extramural agencies, as contrasted with in-house results.

Encourage practical application of promising research findings by offering developmental grants to equipment manufacturers and others

Introduction

The quality of the environment

In the last 10 years the Congress of the United States has increasingly interested itself in the impact of population growth, urbanization and industrialization upon the water, air and soil environment. This interest is manifested in an increasing number of legislative acts emanating from several committees in both the House and the Senate.

Administrative implementations resulting from these legislative directives have now had cumulative experiences running from 10 years to less than 1 year. Sufficient activity, however, has been engaged in to warrant a review of where we now stand in relation to the objectives originally formulated.

The present document attempts such a review, with full recognition of the difficulties and limitations in any effort to assess both national policy and resultant effects in fields as broad as water, air and soil pollution. Although each of these areas of interest has similar philosophical implications, they differ significantly in quantitative aspects, in geographic extent, in responsiveness to public, and private decision and in financial loads imposed upon offenders and values upon beneficiaries.

Waste output, for example, measured in gross terms of tons per day for an assumed urban unit of 1 million people, has relative order of magnitude, as follows:

(*a*) Sewage: 500,000.
(*b*) Refuse (solid wastes): 2,000.
(*c*) Discharges into atmosphere: 1,000.
(*i*) Particles: 150.
(*ii*) SO_2: 150.
(*iii*) Nitrogen oxides: 100.
(*iv*) Hydrocarbons: 100.
(*v*) Carbon dioxide: 500.

Water pollution has been chosen for major elaboration in the text which follows largely because its legislative history on the Federal level is largest, the record of implementation is more extensive, the magnitude of waste discharge is greatest, and administrative experience in

control and prevention is likewise most elaborate. The problem in water pollution abatement and the attempts at nationwide resolution thereof have, however, many analogies with those increasingly apparent in air and soil pollution, to which less space has been devoted in the present review.

In the exposition which follows, the primary desire has been to determine—

(*a*) What the national objectives in fact are;

(*b*) The factual basis upon which action has been delineated; namely, the impacts of pollution upon man and upon nature in general;

(*c*) The nature and/or the universality of standards of environmental quality;

(*d*) The economic or money benefits resident in costs;

(*e*) The significance of geographical diversity;

(*f*) The validity or invalidity of crisis action; and

(*g*) The identification of underpinning (research and development) required for more effective action and more verification of deleterious effects, if any.

These purposes have been recently translated into realistic congressional values by Congressman Daddario in the following terms:

(1) To improve judgment of alternative actions and timetables in pollution abatement legislation;

(2) To assess the responsiveness of executive agency administrative action to the intent of Congress;

(3) To improve the analysis of costs and benefits to the Nation in areas of subjective judgment, such as aesthetic considerations;

(4) To prevent waste of funds in hasty and ill-considered implementation of pollution laws;

(5) To establish baseline definitions of environmental quality, forecast future pollution loads, and assess the results of abatement activities; and

(6) To arrange for the optimum participation of Federal, State, and local governments, and the private sector in developing and employing advanced techniques for pollution abatement.

The Nature of Water Pollution

Pollution is an unnatural and undesirable change in either the visible or invisible characteristics of a body of water. Pollution may thus be regarded as a condition often traceable to the activities of man and subject to his control. Hence, it is a condition deemed unsuitable at a given time and place for a given use.

Where Nature alone is responsible for variations in water quality, it is inappropriate to describe such changes as evidence of pollution. While the changes may be undesirable, generally they are not susceptible to control by man who must either limit his use of such waters or otherwise adapt to the situation. Thus we find swampland waters used for sources of domestic supply whose natural acidity would cause these waters to be classified as polluted and rejected as unsuitable in other areas where waters normally are alkaline. People living along rivers that drain the flatlands of the prairie accept as a matter of course that these sluggish waterways are naturally destined to be

turbid and therefore not polluted simply because they lack the sparkle of mountain brooks that tumble across rocky beds free of any sediment.

A simple but useful concept, therefore, is to regard pollution as the presence in water of "too much" of something added by man. Too much—so that the water is depreciated for potable purposes, industrial use, or agricultural requirements. Too much—so that it has become unsatisfactory for maintaining aquatic life or for recreational pursuits.

The mere addition of something to a body of water does not necessarily constitute pollution. It is the injury caused by "too much" that gives rise to concern. From a purely technical standpoint the exercise of control consists of (1) establishing limiting concentrations on substances that are prejudicial to desired uses of the water; and (2) securing compliance with means to prevent those concentrations from being exceeded.

TYPES OF POLLUTANTS

The discharge of any materials into waterways that offend the aesthetic senses of sight and smell may be tagged as universally undesirable, and therefore, classified as pollutants. Other substances potentially capable of causing undesirable changes may be broadly classified into two groups:

(1) *Persistent (refractory) materials.*—Those whose detrimental influence is mitigated only by dilution once they are permitted to enter a body of water; and

(2) *Die-away (decay) substances.*—Those that are capable of being assimilated or otherwise converted to an innocuous state by biological purification processes that occur naturally in waterways.

Among the persistent types of pollutants would be included inorganic materials such as chlorides and sulfates from brine processing and irrigation drainage, metallic salts, and other kinds of mineral residues. In recent years, new types of synthetically compounded chemicals have been added to this list. Among these, until the formulation was changed only recently, were so-called hard detergents. And now there are a galaxy of pesticides and complex agricultural chemicals that are being washed from the land into waterways. A common characteristic of all of these substances is that when they do get into a waterway their undesirable effects on water quality can be mitigated only by dilution, because either they are unaffected by biological decay or they are highly resistant to such influences. In flowing streams their concentration will build up during drought conditions; in lakes they simply accumulate without change.

The second group of pollutants are those of an organic nature that are susceptible to breakdown or destruction by natural biological action. Sewage, for example, is quite unstable in a flowing stream; and so are residues from cannery operations, as well as organic industrial compounds such as phenols. However, as these materials are converted into simpler, inoffensive constituents this self-purification process makes a demand upon the oxygen resources in the water. This may result in the depletion of oxygen levels below those suitable for the maintenance of fish life, and if the organic loading completely exhausts the available oxygen septic conditions will result. Furthermore, where conversion of these organic materials produces nitrates

and phosphates these byproducts have a fertilizing effect on the waters with a resultant proliferation of undesirable aquatic growths; notably taste- and odor-producing algae.

Not all potential pollutants lend themselves to such a neat and simple classification. Radioactivity, for example, does have die-away characteristics; but with some radioisotopes this decay is so slow that they might more properly be regarded as a persistent form of pollution. The same might be said about certain toxic compounds.

Furthermore, some substances exert synergistic effects; that is, they combine in the presence of each other to multiply their individual pollutional potential. This is the case with compounds that impart taste and odor characteristics. Phenolic materials exhibit this tendency. Some of them alone in rather high concentrations cause relatively little taste and odor difficulties; but in association with even the most minute quantities of chlorine or organic materials their undesirable effect is markedly multiplied.

The conclusion to be drawn from this brief outline of the nature of pollution is that we are dealing with an exceedingly complex array of materials and of reactions. This is not to suggest, however, that technical measures have not or cannot be contrived to cope with the situation. It does call attention to the need for professional competence of a high order to diagnose conditions and to prescribe appropriate remedial measures.

IMPACT AND SIGNIFICANCE OF POLLUTION

The impact and significance of water pollution may manifest itself in different ways. As a consequence the "pollution problem" means different things to different people.

To the public at large, pollution asserts itself in terms of offensive sights or smells in a river or lake, or by the evidence of an unnatural taste or odor in the drinking supply. The outdoor enthusiast identifies pollution as any abnormal condition that interferes with fishing, swimming, or boating. An industrial plant manager catalogs pollution as something that degrades the quality of water required for processing, cooling, or steam generation. And to health authorities pollution is anything that may be classified as contamination and a potential threat to public health and safety.

Because of these multiple points of view there is an elusiveness to the definition of pollution. Presumably they all seek, to express the same notion; namely, that pollution is an impairment of quality that is prejudicial to the suitability of water for defined uses. However, this is not at all apparent in the proposals relative to policy and practice for the control of pollution.

Control of pollution has been historically identified as an environmental sanitation measure. However, it encompasses much more than this. It is much more meaningful to delineate the pollution problem as the quality-management element of a water resources program. Today it would be a narrow view, indeed, to conceive of pollution-control efforts designed only with regard to sanitation significance.

Economic and social consequences of water quality degradation compel attention to control measures that are referenced to goals

beyond those associated with public health alone. For example, consider the limitations imposed on chloride-ion (salt) levels in waters to be used for drinking water. Here a concentration value up to 250 parts per million would be acceptable so far as potability is concerned. But from the standpoint of suitability for industrial purposes a water supply with a concentration of salt exceeding even 100 parts per million may lead to accelerated corrosion of piping and equipment and be rejected for steam generation. Thus control of salt content referenced only to consideration of drinking water standards could be criticized for not giving cognizance to the economic consequences of industrial-water suitability.

Another example relates to the control of discharges containing certain metallic ions, such as copper or zinc. If limitations were drafted solely with regard to public health considerations, it is not unlikely that aquatic organisms and fish would be harmed long before the permitted concentrations in the water should present a potential hazard to humans.

Without deemphasizing its public health connotations, the fact is that pollution control may be more favorably administered under arrangements that emphasize evaluation of the impact and significance of all aspects of water quality variations. This concept has been gaining acceptance in State pollution-control practice. At the present time at least 20 States have established independent agencies outside of their health departments for administration of comprehensive control programs; 10 others have created specific agencies for this purpose although they are linked organizationally with the health department.

Similar motivation must be attributed to the 1965 amendments to the Federal Water Pollution Control Act which, among other things, transferred administrative authority for execution of this function from the Public Health Service to a new and separate agency in the Department of Health, Education, and Welfare.[1]

While these changes provide administrative recognition to the impact and significance of pollution control in the social consciousness and political fabric of the Nation, much remains to be done to convert concepts into practice.

The term "water quality management" has been advanced as a more precise and positive description of the goal of pollution-control practice. But notions of what it should encompass and how it might be implemented have lacked definition and structure. Equally elusive has been an understanding of how economic analysis and optimization techniques might be applied in the design of comprehensive waste-management systems.

Meantime, it should be noted that a major objective in the 1965 amendment to the Federal Water Pollution Control Act is the establishment of quality "standards" on all interstate rivers. Among other things, this would seem to reflect the assumption that an adequate basis exists for an evaluation of benefit-cost relationships in setting such standards. Such a presumption has no basis in fact. Indeed, it would appear that even the scientific basis for standard setting is inadequate because in 1963 Congress was persuaded to

[1] In 1966, many of these functions have been transferred to the Department of the Interior.

appropriate $4 million for the creation of two national research laboratories "to establish reliable water quality standards." (See p. 64 "A Staff Report to the Committee on Public Works, U.S. Senate," 88th Cong., 1st sess.) These laboratories currently are in the design stage and presumably will soon be under construction.

Nevertheless, the 1965 amendments specify that unless the States have established standards by June 30, 1967, the Secretary of Health, Education, and Welfare will do so. Presumably this will leave little for the two new "standards-research" laboratories to contribute after they are built, if decisionmaking on standards matches the deadlines set forth in the new legislation.

There is enough visible evidence in waterways of the Nation—or at least in sections of them—to demonstrate the necessity for aggressive action in halting gross and obvious degradation of water resources. Public indignation is aimed primarily at this manifestation of pollution. The data at hand are not at all convincing, however, that the current situation is one of national crisis or that gross degradation is universal. Certainly, no epidemics of waterborne disease have occurred. While there is reason to believe the depreciation of water quality is producing, in some instances, undesirable economic consequences, the assessment of such effects has not yet been sufficiently advanced to make meaningful estimates of benefits versus the cost of appropriate control measures.

STATUS OF SCIENCE AND TECHNOLOGY

The evils of water pollution have been with us a long time. But so have the means to ameliorate most of these evils. There are no technological obstacles, for example, in halting gross and obvious pollution. If raw sewage is being discharged from a community, or if cyanides and phenols are reaching a waterway from an industrial operation, the resulting pollution cannot be attributed to a lack of scientific acumen or technical tools for dealing with it. The abuse of waterways represents a lack of social responsibility.

In brief, and by way of preface to these comments on the status of science and technology, it can be asserted that we already know much more than we are actually applying to improve the condition of our waterways. This is not to suggest, however, that basic research and the development of techniques of water quality management should not command vigorous attention. The question is: Are we addressing our talents most creatively and advantageously?

With respect to scientific matters, not of least interest is a better understanding of the behavior of waterways under varying impacts of pollution loading and the development of "models" for prediction of change. Present empirical formulas and the translation of results from experiments in laboratory bottles fall short of providing the kinds of information that are needed for more economical design of control measures.

Equally challenging is the conduct of a comprehensive inquiry into the physiological aspects of water quality. The major objective of such an investigation would be to determine if unsuspected public health hazards may exist as a result of trace constituents from industrial and other waste discharges that may find their way into water-

ways. Principal attention thus far has been focused on the gross toxicity created by certain compounds. Questions relating to the possible subtle physiological effects of small quantities of metallic ions, chemical compounds and certain natural-occurring substances in water have not been answered.

Concerning the public health implications of water quality it would also be desirable to intensify research on disinfection techniques. With good reason, heavy reliance has been placed on the employment of chlorine for this purpose in the United States. Its virtues as a bactericide are well established. But the same cannot be said concerning the effectiveness of chlorine as a virucide. Present concern with virus infections that may be transmitted through water carriage (hepatitis, for example) would seem to justify emphasis on the exploration of techniques applicable to virus disinfection.

Technological developments

Fundamental principles for the purification of waste waters developed a century ago—gravity settling of solids, chemical precipitation and biological oxidation—continue to be applied to this day. But this is no reason to presume that technology has been static or that current practices are outmoded or inadequate. Significant advances have been made in design of components and in operating techniques. And it can be said that increasing advantage is being taken of new developments in physics, chemistry, electronics, mechanical engineering, and allied technologies.

For example, recent discoveries associated with the performance of polymer chemicals known as polyelectrolytes is already finding application for the improvement of coagulation practice in waste treatment. Use of chemicals for treatment of sewage is an old art and was widely exploited in England in the 1880's and shortly thereafter in the United States. Current experimentation with the use of polymers suggests that we are on the threshold of a new era in the employment of flocculation techniques for pollution control.

Meantime, under the leadership of the Public Health Service a host of so-called advanced waste-treatment processes are being investigated. This program is oriented primarily to long-range needs for safeguarding water quality, when conventional methods of waste treatment, coupled with reliance upon the assimilative capacity of streams, may not prove adequate to meet ultimate requirements for multiple reuse of water. However, the work has short-range implications as well in providing means for removal of so-called refractory pollutants.

Basic objectives of the program are to develop processes for treating waste effluents in such fashion as to (1) concentrate the contaminants and provide for their permanent disposal; and (2) produce purified effluents of such quality that it is suitable for direct reuse.

Among the possibilities for accomplishing these objectives are techniques employing principles of adsorption, electrodialysis, emulsion separation, evaporation, extraction with solvents, foaming, freezing, hydration with gas, ion exchange, and oxidation.

From the standpoint of technological adequacy this research program is believed to be "doomed for success," because some of the processes already show capability of meeting the objectives. The

measure of success will be based not only on effective removal of substances, but on whether the cost is worth the benefits. For every situation this determination will be unique, depending on the character of the wastes to be treated, on geographical and logistical factors and on the intensity of water reuse that is desired.

Science and technology are not static in water pollution control. Processes and equipment are being made available effectively with current problems and for those that are foreseeable in the near future.

RESULTING KEY ISSUES

Water pollution

Emerging from the current review are several key issues relevant to national policy. For purposes of discussion they may be classified into four categories—legislative, fiscal, institutional, and technological.

(1) *Legislative issues*

Neither the original Federal legislation on control of water pollution nor its newly amended version can be regarded as explicit with respect to the national goal. Nowhere is pollution defined.

The preamble of original legislation concerned itself primarily with the exercise of jurisdiction declaring it "* * * to be the policy of the Congress to recognize, preserve, and protect the primary responsibilities and rights of the States in preventing and controlling water pollution * * *."

Amended legislation signed by the President on October 3, 1965, presumably attempts to clarify matters by inserting an introductory sentence to the existing preamble that says: "The purpose of this act is to enhance the quality and value of our water resources and to establish a national policy for the prevention, control, and abatement of water pollution." But, again what is meant by the term "pollution"?

Defining pollution.—For the execution of a program of control—for giving meaningful direction to the attainment of a national goal—there is need to reach understanding as to what constitutes pollution.

Is it the discharge of anything in our waterways? Or is it the discharge of "too much" of something? If so, how much is too much? Is pristine purity the goal we are seeking? Or do we settle for something less, such as maintenance of quality conditions that avoid a nuisance—that satisfy water supply needs—that are hospitable to fish life—that are suitable for recreational purposes? Should the objective be an efficient adjustment to the attainment of water quality that will take into account the benefits and costs of alternative accommodations? Should the objective be the same throughout the Nation? In fact, is it practicable or even possible for the objective to be universally the same?

Until agreement is reached on what we are aiming for, the administration of pollution control will continue to be—as it is now—enveloped in confusion with respect to ultimate objective.

It serves no useful purpose to asseverate, as has one of our highest officials in the Federal service, the following viewpoint on the objective:

> There are still some who hold to the belief that the utilization of a stream as a receptacle of waste is a legitimate use of water, consistent with water pollution control policy. * * * Whatever may have been acceptable or unavoidable in

years past, however, it is clear that our goal now and in the years ahead, in an age of vast industrial expansion and rapid urbanization, must be to prevent any sort of water pollution.[2]

While one might agree philosophically with the conclusion, there still remains the question of what kind and what amount of "waste" constitutes pollution. In brief, pollution is a relative matter. For all practical purposes, as previously noted, pollution of water is an alteration of quality prejudicial to the suitability of the water for defined uses. If the addition of a waste effluent does not adversely affect desired uses, such waters might well not be considered as polluted.

No clue may be found in Federal legislation, nor in the pronouncements or practices that pertain to its application, that provides enlightenment on how pollution should be defined. It might be noted, however, that in drafting a Suggested State Water Pollution Control Act based on the experiences of successful State agencies, the Federal Department of Health, Education, and Welfare punctiliously asserts: "The most important definition in the act is the definition of pollution." [3]

While the Federal agency saw merit in laying down a detailed guideline for the States it has seen no virtue thus far in adopting a similar guideline for its own conduct.

Meantime, the Congress and the public are barraged with statements from the U.S. Public Health Service that stream pollution is increasing and that "billions" of dollars will be needed for corrective measures. So long as the Federal authorities sidestep the issue of defining what is meant by "pollution" there is reason to question the validity of appraisals of the magnitude of the problem and the estimates of costs associated with remedial action.

Who is in charge?—Another key issue with respect to legislative intent relates to the question: Who is in charge? This involves the sensitive area of relationships between Federal and State authorities and those who are subject to regulation.

Laid to rest in 1948 with the passage of the first Federal Water Pollution Control Act—but only after years of prolonged debate—was the matter of whether or not the National Government should assert a direct role in stream cleanup efforts. The decision was yes. But in reaching this conclusion in Congress envisioned a partnership wherein Federal actions would be designed to abet and supplement State efforts, but not to supersede them unless a State actually defaulted in meeting its obligations.

Three sections of the original and recently amended Federal Water Pollution Control Act are positive with respect to congressional intent. One of these is the preamble, which declares it to be national policy to recognize, preserve, and protect the primary responsibilities and right of the States in preventing and controlling water pollution.

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[2] James M. Quigley, Assistant Secretary of HEW, in a 1961 address before the Izaak Walton League in Chicago.

[3] As set forth in the May 1965 revision of the act we read: "'Pollution' means such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the State, includi g change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the State as will or is likely to create a nuisance or render such waters harmful, detrimental, or injurious to public health, safety, or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish, or other aquatic life."

Another section, relating to interstate matters, calls upon the Federal authorities to "encourage compacts between States for the prevention and control of water pollution."

Finally, in that section of the act dealing with Federal enforcement, the procedures outlined are designed to stimulate and not attempt to emasculate the exercise of State responsibilities.

These sections of the act in particular, and other provisions in general, would seem to leave no doubt that it was the intention of the Congress for the Federal Government to employ its resources to act in concert and not in competition with State efforts. There is reason to question, however, that the conduct of several components of Federal activity are achieving this purpose.

Perhaps the major departure from the intent of the Congress has occurred in the conduct of relationships on enforcement. Originally, the act provided for a four-step procedure in situations where a Governor may request intervention on interstate pollution, or when the Secretary of HEW believes that such pollution may exist.

The first step is the calling of a conference of such State and interstate agencies that may be involved for the purpose of exchanging views and examining evidence relating to the alleged conditions.

The second step is a determination by the Secretary, based on the evidence, as to what, if any, remedial measures should be undertaken by the appropriate State agency; 6 months were allowed for the State to initiate corrective action.

If at the end of this 6-month period the Secretary was not satisfied that appropriate action has been taken he is empowered to call a public hearing. Based on findings of the hearing board a formal notice and schedule for compliance would then be issued to those persons (public or private) who are causing pollution. This constituted the third step in procedures spelled out in the act.

The fourth and final step open to the Secretary, if compliance lagged behind the established schedule, was to refer the matter to the U.S. Attorney General for prosecution.

What has troubled the States is that these carefully drawn procedures, designed to encourage the exercise of their responsibilities and to provide backup support, have been bastardized in a manner that does exactly the opposite. What has occurred is this: The Federal authorities have not sought to confer with the State agencies in the sense that the parties concerned are brought together for an intimate exchange of facts and viewpoints. Instead, the so-called conference is conducted virtually as a public hearing, generally in the ballroom of a large hotel and with advance publicity guaranteed to generate the attendance of hundreds of people.

These meetings have been shrouded with the atmosphere of an adversary proceeding. Formal presentations of the Federal authorities often leave no alternative for the States than to adopt a defensive attitude. Conditions are hardly conducive for dispassionate appraisal of the issues involved and their resolution. Quite to the contrary the State conferees are confronted with "recommendations and findings" that are normally formulated in advance of the conference by the Federal authorities and therefore not necessarily reflective of subsequent State evidence.

The amendments to the Federal act, which were signed into law only on October 3, 1965, call for a fresh approach to Federal enforcement

ventures through the promulgation of water-quality standards. The States are given the initiative. However, it remains to be seen if the proceedings so carefully spelled out for this purpose will be executed in accord with their intent. Here again the act specifies that a conference be conducted among State and Federal agencies as a first step in the resolution of differences. And only after this step is it ordained that a public hearing be undertaken.

Apparently sensitive to the dissatisfaction previously registered with the Congress by the States because of violation of the style and substance of so-called conferences, Congressman John A. Blatnik, one of the authors of the amendments, carefully stressed that the first step to be taken by the Secretary of HEW in a matter under dispute, was the conduct of "an informal conference with all parties concerned." Unfortunately the bill itself does not contain the word "informal."

With respect to that section of the act calling for encouragement of the formation of compacts among States for the control of interstate pollution there has been no apparent diligence displayed by the Federal administrators in furthering this. At the present time eight interstate agencies are recognized by the Public Health Service as eligible for Federal aid because of this probable identification with some aspect of water pollution control. All of them owe their existence solely to the initiative of the States involved; and the four that are concerned exclusively with pollution abatement came into existence prior to enactment of the Federal act in 1948. If the Federal authorities have sought to encourage compacts, the results have not yet manifested themselves.

(2) Fiscal issues

The once-traditional notion that installation of municipal sewage-treatment facilities is solely a local responsibility to be paid for with community funds no longer is valid. Beginning in 1956 the Congress established the pattern of appropriating annual sums to furnish Federal financial assistance to communities for this purpose. For the first 5 years the annual total was $50 million; but this has been gradually increased and for fiscal 1966 the amount is $91 million. Originally intended to stimulate sewage-treatment undertakings in the smaller, financially distressed communities, a grant of Federal funds is now regarded as a prerequisite by virtually all communities before such projects are initiated. Originally the size of a project grant was limited to 30 percent of the cost, but in no case to exceed $600,000; the latter limit has now been raised to $1,200,000 for a single project. Multicommunity projects are eligible for as much as $4,800,000 or double the amount previously authorized.

A few States also provide limited financial assistance. In Pennsylvania a unique plan was inaugurated in 1956. It provides that every community upon completion of sewage treatment is eligible for an annual State subsidy of up to 2 percent of the cost of the project. The amounts made available for distribution each year is dependent upon legislative appropriations. In November 1965 the New York State electorate supported overwhelmingly a bond issue of $1 billion. The proceeds will permit the State to allot to a community a 30-percent share of the construction cost and prefinance a 30-percent Federal share, later reimbursable to the State by the Federal Government.

Taken together the State and Federal grants in New York State are intended to defray up to 60 percent of the cost of local projects. The estimated cost of the 6-year program is $1.7 billion.

While there have been doubts that communities are incapable of financing sewage disposal requirements (for example, using revenue bonds retired from sewer service charges), the principle is now well established that a substantial share of this burden should be carried by the Federal Government. And it appears to be only a matter of time before similar convictions will arise with respect to supplemental funds from the State. All of this has evolved without any documentation anywhere to demonstrate capacity or inability to pay via local service charges.

Disposition of Federal funds.—With respect to Federal expenditures for implementing the Water Pollution Control Act two key issues may be identified: (1) How much money should be appropriated; and (2) for what specific purposes shall it be allocated?

In discussing these issues an examination of the appropriations for fiscal 1966 is illuminating. Here we find that $91 million is allocated for construction grants, an increase of only 1 percent over the previous budget. For all other purposes (planning, research, enforcement, training, etc.), the operating budget is $44.5 million, an increase of 27 percent over last year.

If the national goal is to expedite the abatement of pollution—and a major route to accomplish this is by constructing adequate control facilities at sources of pollution—then it would appear that the Federal amounts allocated for this purpose are out of balance with the funds made available for Federal administration. And if budget allocations and percentage increases may be regarded as appropriate criteria of where emphasis is being placed, it would appear that construction funds hardly ranked in importance with the emphasis placed on research, planning, and administration.

Another aspect of budgetary decision that claims scrutiny is the relative weighing accorded to appropriations for Federal enforcement with those allocated for strengthening State administration of control. Here we find $4 million for Federal activities. However, only $5 million is earmarked for distribution among 54 State and territorial agencies and 8 interstate agencies. Incidentally, it might also be noted that while funds for Federal enforcement activities were increased 8 percent, there was no increase in the total allotment for the States. Among the conclusions that might be drawn is that Federal money is being harbored to broaden Federal control at the expense of strengthening the role of the States. This, of course, is contrary to the expressed declaration of the act.

Construction grants program.—The adoption of grants-in-aid may be regarded as an acknowledgment that Federal enforcement action could not be any more effective than State efforts in obtaining municipal compliance unless it was accompanied by infusions of financial subsidy. This is a point to be kept in mind when assessments are made of the relative merits of Federal versus State performance in dealing with the complexities of stream pollution.

Lacking the sugar of subsidy to sweeten public attitudes toward compliance the evidence suggests that during the first 8 years of its trial the Federal impact added little to what was already being accomplished by many of the States.

In 1956 the Congress made the first appropriation for subsidies to municipalities. The amount allocated to each State for distribution to municipalities was, and still is, proportioned to a formula based on a ratio of population coupled with per capita income of that State to the entire United States. However well this may satisfy equitable distribution from a political standpoint, it has not been well suited to meeting pollution-abatement needs. A recent amendment will seek to remedy this in part by providing that, when funds should be appropriated in excess of current authorization, the excess will be allotted on the basis of population.

Under the prevailing allocation scheme it turns out that States whose sewered population is quite high may not be eligible for much more Federal aid to stimulate treatment plant construction than are, for example, the Virgin Islands or the island of Guam. Each of the latter are eligible for about $1,500,000. Yet, a State like Indiana receives only $2 million. Since few municipalities now show any disposition to build treatment works without a Federal grant, the result is that State programs are geared to the amount of Federal money allocated for distribution among municipal claimants.

It may well be concluded that consideration should be given to a more rational procedure for allocating Federal funds to municipalities. Up to and including 1965, over 30 Federal grant-in-aid authorizations for State and local subsidy have been provided. In each instance, elaborate administrative machinery had to be established to handle these in accordance with legislative intent and with maximum equity. Such machinery normally requires at all levels of Government, increasing numbers of advisory groups, fiscal reviewers, auditors, and post-checkers. It is about time to reconsider this whole procedure and hopefully evolve a blanket tax return to local areas to be used for the purposes intended. When it is recognized that, in addition to the grants in the pollution abatement category, myriads of other grants have been initiated, it is no surprise that many officials are appalled by the labyrinth of Federal supplements through which he must now wander.

The search for a simpler fiscal relationship does not denigrate the leadership function of the Federal Government or the unevenness of correctives in the Nation. The general grant, sometimes used in the depression thirties, was attractively simple in contrast to today's increasingly intricate web of Federal grants. Unfortunately, the flexible general grant has declined, while the closely controlled categorical grants have multiplied greatly.

Quite aside from exploring possibilities of a more rational formula for allocating Federal aid—but allied to it—is a recommendation that an appraisal be made of the merits and shortcomings of the sewage-disposal grant program. Ten years of experience have been accumulated on this relatively new form of Federal aid. How effective has it been? Are appropriations realistically geared to aspirations? What can be learned from the experiences of various States who have acted as "middlemen" in the distribution of funds? These questions are merely illustrative of what it would be useful to know in further development of national policy.

A similar inquiry would be justified in connection with Federal aid made available to the States for administrative purposes.

Incentives for industrial waste control.—Not the least of fiscal policy issues relating to pollution abatement has been the question of providing incentives for industrial establishments. More than a quarter century has elapsed since the National Resources Planning Board, in response to a request from President Roosevelt for recommendations on national policy for pollution abatement, suggested that consideration be given to providing grants to municipalities and loans to industry as a means for accelerating stream cleanup.

Grants-in-aid to municipalities became an established policy in 1956. However, little sentiment has been crystallized for providing construction loans or any other form of subsidy to industry. The prevailing view has been that the private sector of the economy must recognize the burden of preventing pollution as an element of its production costs.

At various times proposals have been suggested in the Congress to offer industries the privilege of accelerated depreciation on capital investments made for pollution abatement. The Treasury Department has not favored this special-classification proposal. Industries have had mixed feelings regarding the virtues of this type of rapid writeoff of corporation taxes. Large corporations, for example, have pointed out that they find it of dubious benefit as to whether they pay required taxes sooner or later. They point out rapid tax amortization is hardly an incentive; it does nothing more than provide some flexibility with respect to payments.

Several States (such as Massachusetts, Vermont, New Hampshire, Maine, Oregon, Idaho, Wisconsin, North Carolina, and New York) do offer a subsidy to industry in the form of property-tax exemptions for land and equipment devoted to air or water pollution abatement purposes. The resulting tax benefits appear to be minimal. It is questionable whether this incentive can be credited with having much of an impact on the decision of an industry to undertake a pollution abatement program.

An incentive proposal receiving increased attention is the imposition of a sliding scale of charges related to the quality and quantity characteristics of industrial effluents contributed to streams. The smaller the amount of polluting material contributed the lower would be the charge imposed. Advocates for the adoption of this policy see this as a means for furnishing every polluter with an immediate and well-defined incentive to minimize his liability and the automatic result would be cleaner streams.

Not so clear, however, is what would happen to the condition of streams where contributors of pollution might find it more convenient to pay the charges rather than take measures to reduce the pollution. And not yet illuminated is the matter of who could collect the charges (the State in which the water is located or the Federal Government?) and for what purpose it is intended that the acquired revenues be used. At the 1965 White House Conference on Natural Beauty, one speaker envisioned possibilities of the Federal Government collecting such a tax to sustain a revolving fund of several billion dollars, which would be available for beautification purposes.

The virtues associated with employment of "effluent charges" as an industrial waste control incentive seem to have originated from a misinterpretation of practices in the Ruhr Valley of Germany. Here

a group of watershed associations—organized as cooperative undertakings, the membership of which includes municipalities, industries, recreation interests, and other quasi-public and private constituencies with a stake in water use—provide a variety of services to insure optimum use of the resources.

Among other things, these associations offer a choice to its members of treating their wastes individually to a required standard or to utilize centralized treatment facilities built by the association. Industries that elect to satisfy their waste effluent control requirements in full or in part by utilizing association operated treatment facilities pay a charge based on the quality and quantity characteristics of their waste. But it is to be noted that this charge is made for a service rendered; namely, the treatment or modification of a wastewater effluent. Furthermore, the judgments made with respect to maintaining certain quality conditions in a stream, based on decisions that reflect a weighing of benefits and costs, is not made by a regulatory agency remote from the region, but by the members of the association who represent the various interests in the valley and are assessed for their share of this cooperative undertaking.

The attempt to transpose the Ruhr Valley practice of "effluent charges" as an incentive device for control of pollution, without giving recognition to institutional arrangements through which such charges might be made effective for their intended purpose, represent a grave misunderstanding of the procedure.

Actually, the effluent-charge philosophy employed in Germany should be regarded as representing nothing more nor less than the application to an entire river system of the principle of municipality imposed waste-load surcharges. The latter practice has won increasing favor in the United States since its introduction at the turn of the century, as an equitable means for sharing costs of treatment facilities among industrial users of a community provided service and for encouraging reduction of pollution loads at their source. Here again it should be reiterated that the incentive is not a tax, it is for a service rendered and the decision to utilize this service or to provide alternate means is optional upon the producer of the waste.

What is to be emphasized is that the entity imposing the surcharge—in this case a municipality or metropolitan sewerage authority—earmarks and employs this revenue for building and operating facilities to satisfy a specific and universal requirement. To apply this principle to a river watershed or original area requires a type of institutional arrangement that has not received much attention in the United States. What this involves will be discussed later.

Incentives to industry may also stimulate undue emphasis upon waste treatment, rather than upon "in-house" reduction or even elimination of wastes.

The private sector of our economy has not been entirely deprived of governmental aid in coping with industrial pollution control. A substantial amount of industrial waste (perhaps as much as half of the total produced) is already being handled in municipal sewage treatment works. These municipal facilities are eligible for Federal subsidies amounting to at least 30 percent of their cost. In addition, several States provide some form of limited financial aid to communities for treatment facilities. Therefore, wherever industries pay a pro rata

share for the use of municipal facilities their costs are reduced in proportion to the subsidies already received by the municipality from Federal and State funds.

Furthermore, while industry has regarded it a dubious blessing that Government research may develop solutions to industrial waste control problems, which heretofore may have been conveniently cataloged as technologically unsolvable, the fact is that as insistence mounts for correction of these problems industry may benefit from findings that have emanated from Government supported research.

In terms of dollar expenditures, federally sponsored research is not insignificant. In fiscal 1966, for example, the budget of the Public Health Service, Division of Water Supply and Pollution Control, has allocated $6 million for research grants (an increase of 44 percent) for in-house research, technical, and training activities. Industry must regard itself as one of the beneficiaries of whatever these investigations contribute to the art and technology of pollution control.

(3) Institutional issues

With respect to institutional arrangements the issues that have dominated public debate are:

(1) On what level of government—Federal or State—should primary reliance be placed for the administration of pollution control; and

(2) Where in the Federal Establishment among the several agencies engaged with water resources activities is it appropriate to lodge responsibilities for pollution control?

Preoccupation with these issues has submerged attention to the potentialities of other institutional arrangements for effectuating pollution control. Considering the billions of dollars that are estimated to be spent for this purpose, and taking into account shortcomings inherent in both State and Federal regulatory approaches, it would be in the national interest to explore the potentialities of various instrumentalities that could be suited to the management of river quality.

The conservancy district procedures pioneered in Ohio and the recently enacted legislation in Michigan to promote establishment of watershed councils and river district management agencies are illustrative of institutional devices that claim attention in the search for more effective solutions to the "pollution" problem than are currently employed.

In this connection, who can say that the potentialities of the interstate compact have been adequately proved? This device has unique capabilities, a number of which have not yet been exploited in water resources management.

More on this matter of institutional arrangement will be discussed in the section of this report dealing with mechanisms for the implementation of policy. Something further needs to be said at this point about the two issues that have captured primary attention.

Issue No. 1.—As matters now stand, it appears destined that water pollution control affairs will be increasingly dominated by activities and actions on the Federal level of Government. Along with similar tendencies in other Federal-State relationships, the central fact is that in pollution control State prerogatives are being attenuated rather than strengthened.

While it must be acknowledged that administration of pollution abatement in some States may in the past have left a good deal to be desired, this can hardly be accepted as evidence that Federal control must be thrust upon all States. Yet this view is being aggressively promoted.

As a result two things are happening. State agencies instead of being inspired to put forth their best efforts are either being embroiled in jurisdictional matters and thus rendered less effective, or they are being diverted from matters they regard as having priority in order to accommodate to Federal edicts. The Federal bureaucracy is swelled in manpower (often by stripping the best from State agencies) and financial resources to undertake what the States are being handicapped in doing.

Those who understand the intricacies—technical, economic, and social—of pollution-control endeavors, question the propriety and the desirability of the National Government assuming the central role for decisionmaking and responsibility. Among other things, they point to the fact that contrary to undocumented pronouncements of those who have recently "discovered" the pollution problem, the record of many State agencies has been outstanding in dealing with it.

The record shows, for example, that long before pollution became a high-pitched political issue—and with only modest outlays for administration and with no subsidies available to municipalities—substantial progress was being made by the States in advancing water pollution control. In this connection one might scrutinize accomplishment prior to 1956 in such States as Illinois, New Jersey, Wisconsin, Indiana, Ohio, Iowa, California, and Pennsylvania, to name some of those with outstanding records. (In Illinois, for example, less than 2 percent of the population had sewage treatment in 1929; by 1964 the percentage had increased to 98.6. Other States have equally impressive gains.)

Some 30 years ago, as revealed in testimony before a congressional hearing, ships in Philadelphia could not embark passengers on the evening before sailing because the stench of the Delaware River was unbearable; such a condition does not prevail today.

Reports of the Chicago Sanitary Commission a half century ago show that the streams in that metropolitan area were so grossly polluted with sewage solids that chickens, dogs, and cats could scurry back and forth across the scum-encrusted surface. Not many years later Chicago began the construction of sewage-treatment facilities that today are acclaimed as one of the "seven wonders of the engineering world."

These examples are cited not to suggest that everything is well in the control of water pollution. But they might serve as documentation that solutions to the problem were being effectively advanced somewhat antecedent to the last few years and at places in the Nation rather remote from Washington. What is still lacking is a realistic documentation of the present quality of our waters and of the public and private waste treatment plants actually built over the last 5 to 10 years.

Issue No. 2.—An assessment of the appropriate place within the Federal establishment to lodge responsibilities for pollution control calls for a bit of background.

The current formal transfer of these responsibilities from a division within the Public Health Service to a separate division within the Department of Health, Education, and Welfare, is heralded by its proponents as an "upgrading" of this activity. Other observers interpret this move as leading to an estrangement of cooperative relationships in technical aid and services between the Federal Government and the States, which had long been fostered under the auspices of the Public Health Service.

Beginning in 1912 that agency created a Streams Investigation Station in Cincinnati, the purpose of which was to conduct fundamental research on water pollution and to assist the States in advancing their programs. Over the years this modest venture produced the richest dividends. Cincinnati became the Mecca, not only for State personnel, but for people throughout the world who sought knowledge on pollution control techniques.

It was an acknowledgment of the competence and capabilities of the Public Health Service in the field of water pollution that led to designation of this agency as the appropriate one to administer the Water Pollution Control Act, first passed in 1948. The act was designed to strengthen State administration and specifically cited the intention to provide Federal technical aid and services toward this end. In this area of endeavor the PHS not only excelled, but had developed a nice sense of rapport among the States.

Conservation groups who had fought for the passage of legislation that would have supplanted State control with Federal control, not only were dissatisfied with the act, but also with the fact that by tradition the PHS was more scientifically oriented than regulatory minded. Thus what might have pleased the States in terms of a partnership relationship was not at all acceptable to those who favored aggressive Federal control.

When the act was amended in 1956 to strengthen enforcement provisions under the auspices of the Secretary of Health, Education, and Welfare, the designation of the Surgeon General of the PHS to administer the act was continued. But in 1961 when further changes were made to emphasize enforcement the administrative responsibilities were given solely and directly to the Secretary of HEW. Although throughout these changes the Secretary continued to use the PHS for conduct of the program, it gradually became apparent to the States that they were actually dealing with two different entities in PHS—a new group intent only on enforcement aspects and the original component that now retained only those duties related to the technical and grant-in-aid elements of the program. As time went on the pace of intervention in matters relating to enforcement increased and it became quite obvious that the dominant thrust of PHS activity was to be in the direction of compliance proceedings.

The 1965 amended version of the previously twice amended act establishes a Water Pollution Control Administration in the Department of Health, Education, and Welfare. Thus the Public Health Service has been formally stripped of all administrative concern with pollution control.

Whether or not this event represents an "upgrading" of the status of water pollution affairs in the Federal hierarchy remains to be seen. Some observers believe that this is only an interim step. To give

substance to this view is the introduction of a bill in the Congress by Senator Frank Moss (S. 2435 submitted on August 19, 1965) to redesignate the Department of the Interior as the Department of Natural Resources and to transfer certain agencies to the Department. Among the activities recommended for transfer are the water-pollution control functions of the Secretary of HEW.[4]

The arguments supporting such a change follow this line of reasoning: Pollution of water has an impact on the economy of the Nation that goes beyond considerations of health. Hence, the administration of control measures should be centered in an agency that has broad experience in matters relating to water resources. The Interior Department would appear to qualify in this respect by virtue of the fact that several of its component units—such as the Geological Survey, Fish and Wildlife Service, and Reclamation Service—have long been identified with varied aspects of water uses and development. Furthermore, its Bureau of Mines is a logical unit for assignment to mine-acid drainage control. What the future holds in the area of relocation of administration of Federal policy is difficult to prophesy.

(4) Technological issues

Any discussion on technological issues should be prefaced with some comment on the state of the art. It is not uncommon to hear it said that nothing new has been added to sewage-treatment technology for a half a century.

It is true that no spectacular innovations have occurred with respect to basic processing components. This may be regarded as a tribute to the engineers and scientists who pioneered the art. They were so thorough in uncovering fundamental principles and so ingenious in applying them to practice that latter-day contributions may be regarded primarily as refinements of component design and operating techniques. But this is no cause for belief that methods are outmoded or inadequate; they may not be fully employed, but they are available.

The technological issue that does command attention is a tardiness in the application of a system-design concept in the planning and operation of stream pollution control endeavors. The challenge here is to devise and apply a combination of measures to attain desired quality at the least cost.

The traditional approach to pollution control has relied primarily upon the installation of treatment facilities at points of waste discharge. Actually there are a variety of methods for mitigating pollutional effects and enhancing the quality of waters.

Among them may be cited low-flow augmentation, a proposition that is currently being promoted by interests allied to the construction of multiple-purpose reservoirs. Operationally, the practice of augmentation has not yet been effectively geared to quality control requirements.

Another alternative is the mechanical reaeration of streams. This technique has not yet been given the consideration that it should undoubtedly command in view of the progress made in the development of aeration equipment.

[4] This was accomplished by Presidential Order in 1966.

Still another technical alternative is the storage of waste-water effluents and scheduling of their release in accord with variations of streamflow. This practice is creatively suited to take advantage of hydrologic variability in the management of river quality.

These are but a sampling of technological methods that may be used separately or in combination to optimize pollution control endeavors. The opportunity of applying them is hindered, however, because Government policy and the existing laws and institutions for its implementation are wedded almost exclusively to the exercise of regulatory functions; namely, the promulgation of prohibitions and their enforcement.

Under these circumstances conditions are not compatible for the exploitation of the new tools and techniques for systems design and operation in the management of river quality.

Among other technological matters that lay claim for attention from the standpoint of public policy, there are three that deserve comment: Storm-sewer separation, deep-well disposal of wastes, and mine-acid drainage control.

Storm-sewer separation.—On the basis of what must be regarded as incomplete evidence of benefits to be derived the Federal panic button has been pushed concerning the pollution of rivers caused by overflow from community sewers during storm periods. The Congress has been told that cities must be equipped with two separate sewer systems—the existing network modified to exclude the entry of anything but sewage and a new one added for the exclusive purpose of conducting rain runoff directly to the river. The cost—to be financed by substantial Federal grants—is estimated to amount to $25 to $30 billion, or even more. (See "Pollution Effects of Stormwater and Overflows From Combined Sewer Systems," U.S. Department of Health, Education, and Welfare, Public Health Service Publication No. 1246, November 1964.)

With commendable prudence the Congress has not yet committed itself to wholehearted acceptance of this proposal. But it did provide in the 1965 amendment to the Water Pollution Control Act its authorization of $20 million annually for the next 3 years for the purpose of assisting demonstration projects related to methods for controlling discharge of inadequately treated wastes from sewers that carry storm water.

The issue is this: If storm water runoff is segregated will the benefits be commensurate with the investment required? All we know is that storm overflows bypassed by sewage-treatment plants may contribute—at the most—about 2 percent of the total pollution load entering the Nation's streams. Those who are advocating storm-sewer separation might be challenged on another point: Simply to segregate such flow for direct diversion into a stream would seem to have dubious value because storm water, at least in its first flushing, carries a considerable amount of pollution originating from debris on streets and roofs.

Deep-well disposal of wastes.—Searching for ways to minimize the cost of keeping difficult-to-treat liquid wastes out of streams, industrial enterprises are evidencing a lively interest in using deep wells for this purpose. This practice was pioneered by oil-well operators and

later by processors of brine deposits. In both cases the extraction through wellholes of either oil or brine liquors left the processors with the problem of getting rid of large quantities of unwanted salt water. When State regulatory authorities called a halt to the discharge of this salt water into streams the processors took the obvious step of returning this liquid back into the earth via disposal wells.

The relative ease and economy of this practice has captured the attention of other industries with a liquid waste disposal problem. As a result such wastes as spent acid are being pumped underground. While this may solve the immediate problem of preventing stream pollution it raises the question if adequate safeguards are being employed to the prevention of ground-water pollution. According to the U.S. Geological Survey there is a paucity of knowledge about the movement of underground water.

The public policy issue presented is this: Do our State and Federal regulatory agencies currently possess sufficient knowledge to provide assurance that present and proposed deep-well waste disposal installations will not ultimately produce irreparable quality deterioration of ground-water resources? If the answer is "No," then prudence would suggest that governmental authorities discourage this practice.

Mine acid drainage control.—Efforts to devise and apply measures for the control of acid drainage from abandoned and active coal mines, with only a few exceptions, represent, until recently, a dismal record of frustration and ineffectiveness.

Pragmatic approaches toward amelioration of mine acid pollution had their origin in the 1930's when air sealing of mines was recommended by the Public Health Service to provide unemployment relief during the economic depression of that period. Following this, the States of Pennsylvania and Indiana encouraged application of various empirical measures, such as strip mine submergence, chemical neutralization and drainage diversion in efforts to minimize the adverse effects of mine acid. More recently the Ohio River Valley Water Sanitation Commission (Orsanco) promulgated control measures in the eight-State area under its jurisdiction based on an elaboration of the empirical practices that were found to be effective in Pennsylvania and Indiana.

If it did nothing more, this action by Orsanco dispelled the psychology of defeatism which has shrouded attempts to deal with the problem. It brought forth an acknowledgment from the coal industry that practical means did, in fact, exist to ameliorate mine drainage pollution. This prompted State legislatures to remove the legal exemption from control obligations that heretofore had been enjoyed by the coal industry.

Quite recently, several Federal agencies have displayed an unusual amount of interest in the mine acid problem, among them the Public Health Service, the Bureau of Mines, and the Geological Survey. The availability of research funds—supplemented with Appalachia moneys—has resulted in a host of surveys, investigations, and demonstration projects.

It now appears that competition for identification with mine drainage control rather than appraisal of opportunities for coordinated effort is the distinguishing characteristic of these endeavors. Con-

sidering that the amounts being spent are not small—one investigation project is budgeted at a million dollars and several others of similar scope are being planned by the same agency—it would appear appropriate that attention be focused on the disposition of Federal funds for mine acid control with reference to the relative utility of current undertakings and duplication of effort.

Substantial sums are being devoted to rather detailed and long-term survey and research projects. In view of the fact that certain empirical practices have already been proven to be efficacious in minimizing acid mine drainage, the public interest may be better served if a greater portion of the Federal funds were employed at this time in an effort to secure immediate benefits. For example, experience suggests that the construction of diversion ditches to exclude the entry of surface water into abandoned mine workings would yield benefits in acid reduction.

Guiding Principles for Future National, State, and Local Policies

Basic policy questions that confront the Nation today are not unlike those posed 30 years ago when the Congress and the Executive Office of the President riveted serious attention on water pollution control. The debate then, as now, centered on—

(1) How clean should a stream be, and

(2) Which level of government should exercise what responsibilities for the abatement of pollution.

However similar the policy questions, a great difference prevails today in the social, economic, and political climate within which the debate is carried on. Socially, there is a mounting pressure to hasten the cleanup of streams. Economically, the affluence of the Nation is such as to dismiss any question that this desire cannot be satisfied. Politically, proponents of Federal control have come a long way in advancing the concept that this is the "painless," if not the preferred way of dealing with the situation.

Therefore under conditions that exist today it is no longer realistic to assert that the States can maintain their traditional posture of individually discharging primary responsibility for all aspects of water pollution control. This does not imply, however, that the States should be supine in determining the goals to be sought nor should they lessen their efforts in bringing about achievement of desired goals.

WHAT LEVEL OF GOVERNMENT?

In seeking accommodation to the circumstances that now exist, it would be appropriate to reassess and delineate the respective roles of Federal, State, and local entities in this common task of water quality management.

Responsibilities have become blurred, with the inevitable result that contentiousness between the Federal and State bureaucracies have hindered both cooperation and coordination. The initiative, as well as the authority, of the States has suffered from erosion by statements and actions calculated to enhance Federal control.

As a guiding principle for making an accommodation that is compatible with circumstances and needs, this philosophy might be

asserted: Only that which cannot be done effectively at the lowest echelon of government should become the responsibility of successively higher authorities. An analogy presents itself in the accommodation devised for the administration of justice. Except under special circumstances grievances are not brought before the purview of the U.S. Supreme Court without first seeking adjudication in the lower courts. It is submitted that if the present trend of Federal intervention with respect to pollution control continues every facet of this complex undertaking will have to be brought to Washington for decision.

Grassroots responsibility

Several guidelines for delineation of responsibility suggest themselves. With respect to promoting exercise of responsibility at the grassroots level, neither State nor Federal Governments have been distinguished in giving leadership to the establishment of watershed or regional institutions through which the solution of pollution problems might be more intimately harnessed to the interests of those upon whom the burdens and benefits should fall. Yet it is within the framework of such institutions—authorized to plan, finance, design, and operate facilities to satisfy local needs—that perhaps the greatest opportunity may lie for implementing optimum quality-control measures as well as for freeing the State and Federal regulatory agencies of detailed administrative supervision.

National policy might not only declare that instrumentalities of this kind are to be fostered, but also provide incentives for their creation and administration.

One form of such an instrumentality might find expression through an interstate compact—with broader responsibilities and powers, however, than those associated with existing compacts on water pollution. In this connection attention is invited to the compact establishing the Port of New York Authority and to the manner in which this agency is organized to perform a specialized regional service and does so on a self-liquidating project basis without making inroads on the taxing base of the signatory States or the Federal Government. Serious consideration of such a structure is desirable, even with the awareness that it brings with it political problems of what controls the electorate forfeit.

Another type of institutional arrangement—and one which is specifically adapted to a watershed or portions thereof—is a conservancy district. So far as is known the employment of such an agency in the United States for water pollution control has not been given adequate trial, although such agencies have demonstrated effectiveness in dealing with flood control and other aspects of water-resources management.

Perhaps the most sophisticated form of local-entity management of pollution control is to be found in the operation of the cooperative water boards of the Ruhr Valley of Germany. Although they are subject to the broad purview of both the state and Federal Governments these boards are otherwise independent and self-supporting institutions with a record of performance dating back in some cases for half a century.

These examples simply illustrate a range of institutional devices that may be judged applicable to the purposes of engendering effective action on the local and regional levels of government.

In California, a study is being initiated to provide the legislature of that State with a review of possibilities for implementing a region-wide waste-water collection and disposal system and other means for maintaining water quality levels in the San Francisco Bay-Delta area. What is significant about this study is that it is specifically aimed toward analyzing the potentialities of a regional institution that will have the authority and capability to integrate the financing, construction, and operation of a complete physical system. The study is designed also to illuminate procedures to be employed for optimizing water-quality control measures and the methods for allocating costs to beneficiaries.

State responsibilities

State regulation of pollution control has never been favored with budgetary resources commensurate with the responsibilities that it has involved. Furthermore, the effectiveness of State regulation has been in large measure contingent upon persuasiveness in generating response from local entities. After all, it is the municipalities and industries who must actually finance the construction of control facilities and their operation.

This important detail may not be fully appreciated by those who have presumed that Federal fiat has a special kind of magic. Federal fiat lacks vitality without substantial infusions of Federal subsidy. The American Municipal Association made this quite plain in 1956 in testimony before the Congress some 8 years after the first Federal Water Pollution Control Act was passed and dissatisfaction had mounted with respect to lack of accomplishment.

Association spokesmen representing millions of citizens in thousands of local communities in effect said this: "If you expect municipalities to comply with Federal edicts to build sewage-treatment plants, then the Congress has the obligation to provide Federal funds for their construction."

These things are mentioned simply to place in perspective the nature of the problem with which State agencies have been confronted and thus provide a basis for assessing their role in the advancement of pollution control objectives.

It is doubtful that the States can make available sufficient financial resources to satisfy with any promptness the demands resulting from social pressures and the expressions of Federal concern for stream cleanup. In fact, it must be acknowledged that State budgets have long been less than adequate to cope with urgent current necessities to say nothing of laying the groundwork for more sophisticated endeavors.

It would appear, therefore, that the discharge of State responsibilities in pollution control should be concentrated on improving capability in the conduct of routine, but vital, day-by-day operations associated with securing compliance with existing regulations. Promoting the installation of control facilities is basic to this end. But there is something more than this involved.

Perhaps the greatest deficiency in administration of pollution control to which the public can be exposed is failure to deal with the obvious.

The public is concerned with a different—and more pragmatic—set of values than most professional workers when it comes to gaging effectiveness of control efforts. It matters little to a citizen, for example, to be informed of progress being made in conducting research and in drafting comprehensive plans if year after year he sees no diminution of paunch manure being discharged from an abattoir or oil from a steel mill.

Distressing as it may be to shift efforts from systematic investigations and preparation of reports to the more mundane tasks of field inspection and prompt challenging of violations, the fact is that no function of a regulatory agency is more vital—or neglected today—than such activities. Small wonder, therefore, that the public fails to comprehend exactly what it is that control agencies are doing.

In brief, there is a policing job to be done. Aside from the virtues that this holds in furthering abatement of obvious pollution, it enhances opportunities to assure a proper return from the huge investments already made for the construction of treatment facilities. It is common knowledge that these plants, in the absence of routine inspection, often fail to produce results they are designed to achieve.

Unless the States do make the choice of improving their capability to carry on day-by-day operating responsibilities there would seem to be no alternative but that this burden be shouldered by the Federal authorities. Let it be noted that the Federal Government has already initiated in a few States routine "performance audits" of those municipal sewage-treatment plants that have been built with the aid of a Federal grant. If the States had been adequately handling this basic regulatory function there would be small reason for Federal inspectors.

In connection with both the Lake Michigan and Lake Erie Federal enforcement conferences, it was made quite clear that, if the States involved lacked the capability for establishing and maintaining surveillance of discharges from entities under their jurisdiction, the Federal authorities would be prepared to do so.

All of this suggests there is a vital area wherein the States can unqualifiedly find room to assert and exercise responsibilities.

Federal role

The philosophy and wording of the Federal Water Pollution Control Act rather nicely conforms to the view that it should be the policy of the National Government to supplement—not supersede—the responsibilities of the States. It is in the execution of this act from which evidence continues to multiply indicating that the authority, if not the existence, of the State agencies may be jeopardized.

Such situations command candid examination, in view of the increasing evidence of conflict on what constitutes appropriate Federal responsibilities. They should not be lightly disposed of as simply "politically motivated." The opportunities presented to the National Government to supplement and abet local and State efforts are enunciated in the Water Pollution Control Act. They include financial support to municipalities for construction of sewage treatment facilities; grants-in-aid to States for upgrading administration; conduct of research and training activities; and the development of comprehensive river basin studies.

However, there can be some question as to whether these programs are being adequately implemented. As discussed earlier the formula for allocation of construction funds to the States leaves something to be desired insofar as matching available money to needs.

Any decision to increase the grants substantially should undoubtedly be preceded by an objective analysis of the impact of past grants upon both the rate of correction and the absolute amount of construction compared with previous years.

Concerning grants-in-aid to States for improvement of administration it would be desirable for the Federal authorities in consultation with the States to undertake an evaluation of the use and effectiveness of these expenditures. Where are such funds being channeled: Into research? Into river quality monitoring? For the employment of inspectors? For the conduct of public education programs? For the purchase of laboratory equipment?

Choices for the use of these funds are rather bewildering. Conditions in each State agency will differ regarding matters that should command priority. On the basis of 8 years of experience among so many agencies undoubtedly there are some common denominators for guidance in making choices.

For example, what has been the nature and scope of State research efforts and how productive has this been in realization of the objectives of the agency? Some observers express the view that, if a State agency is already laboring to keep abreast of its regulatory functions, it is folly to invite the diversion of manpower and funds for research.

From an historical standpoint the use of grants-in-aid is regarded as one of the most effective devices available to a central government for stimulating better performance on the part of State and local levels of government. What needs to be examined is whether current implementation of this principle as applied to the administration of State water pollution control programs is effectively oriented.

National policy is also committed to the principle that Federal responsibility embraces the conduct of research and technical training. Such activities have now proliferated to the point where current appropriations (fiscal 1966) total $15,900,000—an increase of 44 percent over the year preceding. This is in addition to more than $9 million allocated for extramural research and training grants. These substantial and increasing expenditures lay claim to the establishment of guidelines by which their validity may be examined and justified.

HOW CLEAN SHOULD A STREAM BE?

Thirty years of debate on national policy relating to pollution control—from which Federal legislation, thrice amended, has evolved—has not been distinguished in providing a practical definition of the goal to be sought. The unresolved question is: How clean should a stream be?

This matter dominated deliberations at the 1960 White House Conference on Water Pollution and produced contradictory recommendations. The first asserted that "users of public waters have a responsibility of returning them as nearly clean as is technically possible." This was followed by the declaration that—

> There is need for a more systematic approach to the evaluation of the water pollution problems to include health, aesthetic and market values. A framework

of analysis must be developed which will provide a relatively precise understanding of benefit cost and which will form the basis for the design of public policies and programs for effective water quality management.

The first recommendation means literally that pristine purity should be the objective, regardless of what costs or benefits may be associated with pursuit of this goal. The second proposes that the objective of pollution control efforts should be the management of river quality conditions so as to yield the greatest overall net benefits from water resources.

At least partial recognition of this latter concept had previously found expression in national legislation, if it can be presumed that the section of the act calling for development of comprehensive river basin programs embraced the notion of identification of costs and benefits. In fact, studies and reports related to comprehensive planning projects account for the expenditure already of many millions of dollars.

However, in the conduct of Federal enforcement conferences it is not at all apparent that findings from these comprehensive program studies are being weighed in the pronouncement of conclusions. Quite to the contrary, the central thrust of the decisions appears to be that all municipalities and industries should provide the maximum degree of treatment technically available regardless of physical, hydrologic, and economic characteristics of the basin.

The anomaly of dedicating substantial sums of money for preparation of comprehensive plans and then not giving them appropriate consideration in formulating action programs at enforcement hearings illustrates the inconsistency that exists with respect to Federal pollution control objectives.

The most recent attempt to develop a meaningful approach to determination of how clean should a stream be, is to be found in the 1965 amendments to the Water Pollution Control Act. A section has been added dealing with adoption of water quality criteria applicable to interstate waters followed by the promulgation of standards for their achievement. The original intent of the Senate version of the act called for establishment of national standards. The compromise measure that was passed offers the option to the States to undertake this assignment. However, should a State not comply and complete this work within 1½ years (June 30, 1967), then the Secretary is authorized to call a conference of the interested parties following which he will promulgate standards. If a Governor of a State is not satisfied with these standards then the Secretary shall convene a public hearing before a board of five or more persons appointed by the Secretary. Decision of the hearing board will be final.

With respect to guidelines to the States and to the Secretary for establishing standards, the act furnishes these clues: "Standards . . . shall be such as to protect the public health or welfare, *enhance the quality of water* and serve the purposes of this Act." [Emphasis added.] Note carefully the italicized phrase. Does this mean that regardless of the uses of a stream or the natural condition with which it may have been endowed that the standard must be established to "enhance" quality?

If this is the objective, then it would appear to be negated in a following section of that act setting forth these guidelines upon which

judicial review shall be based. Should an alleged violator of the standards seek to challenge their validity or applicability, the court is instructed to make a determination as follows:

> The court, giving due consideration to the *practicability* and the *physical* and *economic feasibility* of complying with such standards, shall have jurisdiction to enter such judgment and order enforcing such judgment as the *public interest* and the *equities* of the case may require. [Emphasis added.]

These instructions, it should be pointed out, command consideration of a number of factors other than enhancement of quality. In fact, they spell out rather precisely the considerations that have been inherent in virtually all prior court determinations relating to pollution. Furthermore, these are the considerations that have been stated, or at least implied, in State legislation and which have served as a basis for administrative decisions made by State regulatory agencies.

At this point it is relevant to comment on a frequent criticism that State regulatory agencies spend "too much time" in reaching determinations of pollution-control requirements. Apparently what is overlooked is that in these endeavors the agencies have been thoroughly aware of how the courts will analyze such requirements. They earnestly seek to resolve such complex issues as practicability, physical and economic feasibility, the public interest and the equities involved prior to the formulation of regulations. As a result they have been quite successful in minimizing the need for judicial review and court determination of their actions.

Long ago State agencies learned that resort to court action is not only a costly procedure but a far slower process than is generally realized. It has not been unusual for legal proceedings to stretch out over a period of a decade—and in the meantime nothing is accomplished in actually curbing pollution.

The promulgation of standards—without some cognizance of factors other than the dictum of "enhancing the quality of water"—may disappoint the hopes of those who believe that this may speed up procedures for controlling pollution. Nor can it be said that the recent amendments to the Federal law have as yet furnished a basis for a clear-cut understanding of the goal or objective of national policy in water pollution control.

REGIONAL AND BASIN APPROACHES

Many problems of pollution abatement transcend the political boundaries of municipality, county, and State. Many encompass more than a single stretch or even multiple stretches of a river and its tributaries. Examples of institutional attempts, many successful and some only partial in function, abound in the United States and elsewhere. They evolved historically to meet acute issues. They rarely appeared full blown in order to meet nonexistent or even faintly discernible future problems. Almost everywhere, the regional or basin machinery came into play because of acute problems or threats of obvious emerging hazard. The history of these institutional approaches is one of pragmatic response to challenge—sometimes belated, occasionally with real foresight.

Some selected examples of these approaches are briefly reviewed here. They may be contrasted with simpler, but experienced, efforts

on a basinwide scale on the Potomac River. Here development has been slow and control has been elementary via the Potomac River Interstate Commission, with its severely limited powers. Contrary to much hostile publicity, however, the river in much of its total length is of good quality. Basin development is at its beginning and machinery for its growth and its functions will undoubtedly evolve.

The Ohio River Valley Water Sanitation Commission

This is an interstate compact agency created jointly in 1948 by the States of Illinois, Indiana, Kentucky, New York, Pennsylvania, Virginia, West Virginia, and Ohio, with approval of the Congress of the United States. The purpose of the agency was to abate existing pollution and prevent new pollution by motivating communities and industries to finance and build sewage and waste control facilities. For the most part, the accomplishments herein noted were the result largely of persuasion and rarely of compulsion.

The coordination of these activities took place via the agency known as Orsanco. The district for which it assumed responsibility embraces portions of the 8 States, within the Ohio River Basin, covering an area of 154,000 square miles and a sewered population of 11,400,000. It is drained by the 981-mile Ohio River and 19 major tributaries.

In the 17 years since the creation of Orsanco, $370 million has been spent for treatment on the main river and another $748 million by the communities on the tributaries. Local funds have financed nine-tenths of this capital outlay. Federal grants-in-aid, not available until 1956, account for the remaining one-tenth.

Expenditures by industries for pollution abatement are not a matter of public record. The States report, however, that 1,560 of the 1,723 establishments discharging effluents to streams have installed control facilities.

The local expenditures of more than a billion dollars have resulted in providing sewage treatment for 93 percent of the sewered population in the valley, half with secondary treatment and another quarter with intermediate processing.

In the commission's current program two deficiencies appear. Some 10 percent of the industries still are delinquent in compliance. The second deficiency, in spite of accomplishments, is the limited capability of the State regulatory agencies to keep up with their increasing responsibilities. The agencies require more staff and greater operating budgets.

A considerable part of the activity of Orsanco is pursued through a series of industry and advisory committees. These meet frequently with the commission members and the staff and are often responsible for assistance in developing criteria for stream quality and for providing public education and corporate understanding. Such committees have covered problems of aquatic life, the chemical, coal, metal furnishing, petroleum, pulp and paper, and steel industries, and of water users in general.

The Delaware River Basin

The Delaware River has been the subject of control and development management for over three decades. For most of this period, an institution known as Incodel—the Interstate Commission on the

Delaware River—performed an active, although limited, basin function. Its concern was dominantly with upgrading the quality of the river for all-purpose use. It had to its credit, with virtually only a skeleton full-time staff, the creation of many quality standards reasonably and generally enforced by the participating States of Delaware, New Jersey, New York, and Pennsylvania. This early commission had legislative sanction, limited authority, other than investigative and education, and an even more limited budget. Its basin coverage was some 12,000 square miles.

Increasing dissatisfaction, primarily with the rate of development of the Delaware River and Valley, led to the drafting in 1961 of a new interstate-Federal compact. It was submitted to the Congress of the United States and to the legislatures of the four States for approval and ratification. This was accomplished and a new regional agency is now in existence. Its central assignment is to administer comprehensively all aspects of water use and development in the valley and to promote sound practices of watershed management. Implicit in the creation of the agency was a strong affirmation of acceptence of local responsibility, no doubt accompanied by an equally strong intent to tap existing and future sources of Federal money. A mechanism is now available for determining policies and their implementation according to the desires of the people of the valley. Simultaneously, detailed provision is made for the coordination of existing Federal agency interests—some 25 in all. In the philosophy underlying the institution the Federal Government is a full voting partner, but not necessarily the sole arbiter of destiny or the source of all funds.

The Delaware River Basin Commission has relatively broad powers. Among other functions, it may—

> Plan, design, acquire, construct, reconstruct, complete, own, improve, extend, develop, operate, and maintain any and all projects, facilities, properties, activities, and services determined by the commission to be necessary, convenient, or useful for the purposes of the compact.
>
> Negotiate for such loans, services, or other aids as may be lawfully available from public or private sources to finance or assist in effectuating any of the purposes of the compact; and to receive and accept such aid upon such terms and conditions, and subject to such provisions for repayment, as may be required by Federal or State law or the commission may deem necessary or desirable.
>
> From time to time, after public notice and hearing, fix, alter, and revise rates, rentals, charges, and tolls and classifications thereof, for the use of facilities which it may own or operate and for products and services rendered thereby, without regulation or control by any department, office, or agency of any signatory party.

The life and the activities of this commission have been too limited to assess, as yet, the accomplishments versus the hopes. In any event, the machinery for action, reflective of local, State, and Federal partnership, is now available. There is every reason to anticipate that successful development on a coordinated front should ensue over the near future. Total water management, with an appropriate major ingredient of pollution abatement, will undoubtedly be demonstrated as within the capabilities of a regional entity.

The Ruhr district

The Ruhr district comprises six river basins each under the control of a water authority, the genossenschaft. From south to north on the right bank of the Rhine, the basins are those of the Wupper, Ruhr (itself), Emscher, and Lippe. More or less parallel to the left bank lies a district of small streams tributary to the Rhine, and next the River Niers, which spills across the Dutch border into the Meuse.

The whole Ruhr district has an area of 4,200 square miles (compared with the Ohio River Basin of 154,000 square miles). It is slightly smaller than the State of Connecticut. The largest community is Essen, with about three-quarters of a million inhabitants. The total population is some 7.5 million.

The first special act created the Emscher Genossenschaft in 1904. The term "genossenschaft" literally means "fellowship" or a close association for common benefit. The creation of this institution was the result of mounting abuses of the stream, accompanied by court actions by downstream complainants. The same concepts of association for a common purpose were subsequently given full expression in the organization and mandates of all six river basin authorities of the Ruhr area. All of these were ratified by the appropriate legislative councils and the chambers of parliament in the period between 1904 and 1930. The special law establishing the Emscher Genossenschaft was so well drafted that in substance it was the pattern for all succeeding river basin authorities administratively responsible for pollution abatement and water management in general.

The legal structure of these "associations" was designed to let them investigate, plan, design, construct, operate, maintain, repair, and replace all necessary installations or engineering works for the abatement of the basin's waters. The task was to be accomplished in cooperation and codetermination with all public and private corporations or persons that were themselves polluters or drew benefits from proposed improvements. Financing took the form of public loans for capital improvements and internal allocation of operating expenses to the members of the association, insofar as expenses were not covered by income.

The administrative machinery consists of three groups: (1) The assembly, (2) the board of directors, and (3) the board of appeals. Two categories of membership are recognized: associates or fellows, and participants. Associates are the municipal and rural administrative districts that empty all or part of their waters into the rivers. The participants are mines, other industrial enterprises, railroads, and the like, and public administrative bodies other than the municipal and rural districts, principally communes.

Modifications of these compositions of membership are to be found in some of the districts, where special conditions prevail. For example, in the Lippeverband, special associates are the Federal Republic, the proprietor of the barge canals; the state, responsible for the upkeep of riverbanks; and the waterworks and levee associations.

The governing organ is the assembly. Its delegates are in proportion to annual financial contribution. No single membership category, no matter how large its proportionate contribution, may out-vote the others. The board of directors is the active manager of the business.

The board is the lawful representative of the association, its legal competence being certified to by the supervisory public authority or Ministry, such as the Ministries of Food, Agriculture, and Forestry.

Protests against the decisions of the board of directors can be carried to a board of appeals, on which members of the board of directors may not sit. Nine members compose the board of appeals in the Emscher Association, three appointed by the public authorities and six elected by the assembly. Until the past decade no recourse was available to the courts from the decisions of the board of appeals. All decisions were final. Today, the courts hold that the door should be left open for an appeal to the courts after all other means of adjustment have been exhausted.

Let us look briefly at the results of these administrative instruments and practices. In spite of their current favor in discussions outside of Germany, no significant emulation of these institutions has occurred in the past decades elsewhere within Germany. Since all of the rivers listed in the six districts are small, and the population densities very high, dilution of wastes even after treatment is meager. Many of the stretches of the rivers, therefore, would not meet the quality standards usually acceptable in the United States. In fact, the oldest control system—namely, on the Emscher—has only been able, under most severe loads, to maintain at this time a river which is essentially an open sewer. This situation has forced the association to construct a giant settling plant in which the entire dry-weather flow of the Emscher is clarified. More recently, artificial aeration of the entire river has been undertaken to attempt to alleviate the untoward results of a necessary and inescapable overuse of a stringently limited water resource.

Air Pollution

With air, as with water pollution, the issue posed above all others is whether the real goal is to remove at all times all contaminants at the source. This goal is implied in much official and unofficial discussion. Yet it is obviously untenable. Apart from being impracticable, this uncompromising approach, as in the parallel case of waters receiving wastes, ignores the fact that the atmosphere normally has a great capacity for accepting and dispelling pollutants without causing objectionable conditions. In general, the practical problem of abatement is normally limited to relatively short periods of time and areas of limited extent. In many heavily industrialized regions, however, natural ventilation is so sluggish that objectionable or even critical conditions may be frequent. In a few such areas a more or less permanent pollution problem exists.

To insist on clean air, therefore, has little meaning, unless one defines how clean, at what cost and for what purpose. In the Clean Air Acts of 1963 and 1965 none of these questions are either specifically posed or resolved. It may be assumed that they have been relegated to moving administrative regulations and decisions. If this is so then congressional committees must accept the responsibility of frequent reassessments of both national policy and of fiscal and regulatory implementation.

Implicit in much of the debate is the assumption that conditions in Los Angeles, Donora, and London are characteristic of all the

areas of the Nation. This is far from the case. It has also been assumed that air pollution and disease go hand in hand. The evidence for this assumption is still limited. The response of the individual to varying levels of SO_2 is not too clear. Air pollution is suspect as an etiological factor in the production of chronic bronchitis, but it is difficult to indict it with certainty "since it is but one of many noxious factors in urban life." The same guarded conclusion may be made with respect to emphysema. It is still less than clear that polluted air has any significant impact upon this disease. If anything, the correlation with smoking is far more impressive.

Continued and intensive exploration of the biological effects of prolonged exposure to ordinary urban air pollution is certainly to be emphasized. The present situation is fairly and wisely stated most recently in the Tukey report (PSAC) in the following terms:

> While we all fear, and many believe, that long continued exposure to low levels of pollution is having unfavorable effects on human health, it is heartening to know that careful study has so far failed to produce evidence that this is so, and that such effects, if present, must be markedly less noticeable than those associated with cigarette smoking. Attempts to identify possible effects of ordinary urban air pollution on longevity or on the incidence of serious disease have been inconclusive. Special attention has been focused on lung cancer, which is known to be closely associated with tobacco smoking, and with the inhalation of radon, other radioactive materials, nickel carbonyl, chromates, asbestos, and other chemicals. There are consistent findings of a greater incidence of lung cancer in the cities than in the country, and it is possible that urban air pollution is a contributory factor in this disease. But its role is uncertain except in special situations, such as proximity to industrial plants that handle known carcinogenic materials.

Regardless of current looseness of definition of problem, of place and of effects of air pollution, certain quantitative aspects for the predictable future are important. Almost all projections of social and economic activity between 1960 and 2000 indicate that residues discharged into the air will multiply manifold, due to great increases in population and resulting industrial, domestic, and automotive activities. Electric power production, on all prophecies, will be multiplied threefold or fourfold. Probably two-thirds of this power will still be from fossil fuels. Motor vehicle population, if current public policy is continued, will mount by some fourfold by 2000.

In the motor vehicle and in power production lies the bulk of the air emission problem, via motor fuel and coal, oil, and natural gas. Between them, they account for a major part of the problems with particulate matter, sulfur dioxide, nitrogen oxides, hydrocarbons, and carbon dioxide. Congressional discussions give due recognition to two pressing issues: the control of hydrocarbon emissions from motor vehicles and the development of low-cost techniques to reduce emissions of oxides of sulfur in the combustion of sulfur-containing fuel. In both of these areas, economics and technology play significant roles.

The primary questions as to the Clean Air Act of 1965 are whether its regulatory and research assignments to the Department of Health, Education, and Welfare and the Department of the Interior are best calculated to produce the results earnestly desired by Congress. Unless the agency activities are geared more closely to private corporate developments than is indicated in the recent record with other pollution abatement efforts, the successes are likely to be slow and disappointing.

Certain fundamental questions should be resolved in this as well as in water and land pollution. The magic words of "accelerated research programs" which appear in all the legislation on pollution abatement endow the Federal agencies with a responsibility for developing expertise in dozens of industrial complexes from the combustion engine to the synthetic chemical fibers. In the absence of real and enthusiastic industrial participation, possible only in a climate of joint understanding, such agency expertness in science and technology will be most difficult, if not impossible, to create.

A second dilemma in the air pollution effort should be recognized. The drive toward controls for internal combustion engines to reduce noxious effluents adequately may fall short of present promise and hopes. More important, however, is that the enforcement agency, in the drive, not lose sight of possible more desirable alternatives. In essence, what is required is a radical new approach to the problem of motive power for transportation. Conceivably, the electric powered automobile for many metropolitan uses, the return of metro transit and the creation of more efficient combustion equipment should be explored intensively. The accomplishment of such departures from the installation of devices on existing motive power units requires an integration of effort among a number of Federal agencies as well as with industry. Machinery for such integration is not only lacking, but interagency comity still leaves something to be desired.

An analogous situation prevails with respect to ultimate correctives in the power industry. Fly ash and sulfur dioxide removal is contingent upon the availability of equipment, upon variation in chosen fuels, upon powerplant location, and upon economic feasibility. In these objectives again multiple agency impact and private industry cooperation hold the keys to success. Is such joint implementation by HEW implicit either in legislation or in administrative behavior?

It must be reiterated that, despite widespread concern with the problem, little or nothing appears in most hearings and only limited study has been given to the engineering and economic aspects of proposed performance levels for combustion equipment in relation to air pollution. Physiological tolerances vis-a-vis capital investment costs to attain acceptable levels are rarely discussed or presented.

The Building Research Advisory Board of NAS–NRC recently reviewed this gap in its study for FHA of flue-fed apartment house incinerators. Some 60,000 of these units are operated in the United States. A theoretical ideal goal was the production of no more than 0.65 pound of particulate emission per 1,000 pounds of flue gas. However, a level of 0.85 was recommended by the ad hoc committee as an immediate goal, with 0.65 for some future attainment. Even this more lenient first goal would entail an average investment of $2,500 per unit. A performance level of 0.65 apparently would require electrostatic precipitators at some $8,000 to $12,000 apiece. In addition, they are complex to maintain on such small installations.

In any event, immediate complete compliance with 0.65 would necessitate capital investments from $480 to $720 million. For the lower limit, some $150 million would be entailed. Performance levels hence should be closely related to practicable and economical equipment commensurate with physiologic and aesthetic necessities or desire.

The experience of the Tennessee Valley Authority with its massive coal burning powerplants (perhaps the largest in the world) makes clear the same interlocking of many forces. None of these lend themselves too easily to any generalized legislative requirement. Over at least 10 years TVA has struggled with air pollution prevention. The three basic methods have dealt with devices to control or reduce stack emissions, the elevation of stack-emitted plumes, and actual curtailment of operation or the use of lower sulfur content coal in extreme and infrequent periods of inadequate atmospheric ventilation. So far plant scale removal and recovery of SO_2 for commercial purposes have not been demonstrated as successful.

The experience with stack heights has been illuminating. Progressively the heights have risen from relatively low levels to 170, 400, 500, 600, and 800 feet (Bull Run plant).

All the operations are accompained by semiweekly statements known as "stagnation trend advisories." These on occasion give way to "stagnation alert bulletins." On rare situations, the "extreme local stagnation warning" is issued. In such episodes, operations in fact are curtailed or shut down.

These details are recorded to illustrate the importance of local, regional, or even single plant regulation to create the most satisfactory equilibrium between weather, fuel, and general operating regime.

The air pollution abatement program, therefore, requires (*a*) the determination of whether a real problem exists and where, (*b*) definition of what the problem is, (*c*) the demonstration that economical and effective methods for correction are available, (*d*) the selection of alternatives to compulsion, (*e*) where compulsion is indicated, the provision of wise and fair administration, and (*f*) the placement of administration as close to problem location as possible, often within the municipality or the metropolitan region.

During the preparation of this document, the American Association for the Advancement of Science issued, in 1965, the report of the Air Conservation Commission (Publication No. 80). The Commission made four basic assumptions essential for rational consideration of the problem of air pollution. These are: (1) Air is in the public domain; (2) air pollution is an inevitable concomitant of modern life; (3) scientific knowledge can be applied to the shaping of public policy; and (4) methods to reduce air pollution must not increase pollution in other sectors of man's environment.

Once more a careful study by an eminent group results in a reiteration of basic principles in its list of recommendations. These are few in number, of obvious validity, and rest upon sane administrative practice, tempered by time to assess and to identify problem and solution. In brief, the Commission recommends that—

(1) Scientists in all disciplines become familiar with the available information about air pollution, and they play active roles in informing both the public and public policy bodies of the facts and their significance.

(2) Decisions on what to do about the facts—the actual weighing of risks versus benefits—should be a responsibility of the entire community, including scientists (special emphasis is placed upon the care which must be exercised in the development

of standards for ambient air quality by the conscientious use and documentation of all available scientific information).

(3) Air pollution be viewed as a problem that transcends political boundaries and as one that has global significance.

(4) Communities, metropolitan areas, States, and appropriate Federal agencies should give special consideration not only to the elimination or reduction of air pollution, but also to air conservation planning.

This Commission, as well as all other students of the problem, agree that metropolitan air pollution essentially stems from motor vehicles, power stations, assorted industries, and householders. Strangely enough, individual citizens, by their use of cars, by their increasing demands for electric power, and by the running of their homes, are the principal contributors. Their understanding will be improved by sound monitoring programs, identification of sources and effect, advice of experts, regulations based on sound scientific data, and enforcement of such regulations.

Solid Wastes

In discussing the amendments to the Clean Air Act of 1963, Mr. Harris (Arkansas) presented to the House on September 24, 1965, certain pertinent comments on title II—which deals with the problem of the disposal of solid waste. He stated (p. 24145, Congressional Record, House):

> There are those who feel that this is an unnecessary invasion and interference by the Government into a problem that should be primairly local.
>
> If we accepted the viewpoint of those who feel that the Federal Government is going to assume the responsibility and the obligation of disposing of garbage and all solid waste of municipalities all over the country, then they would be right, but I want to make it abundantly clear here and now that this is not the purpose of the program.
>
> The purpose of this program is research, investigations, experiments, training, surveys, studies, and demonstrations, relating to the operation of, financing, and otherwise disposing of this solid waste product. That is what this program involves.

Thus Mr. Harris succinctly and accurately describes the issues involved in this area of public activity. The Clean Air Act of 1965, as passed and signed, includes title II. By this step, under the guise of facilitating solid waste disposal and reducing air pollution, the Federal Government in fact moves into another area of local responsibility. By a simple declaration of national interest, one local or regional function after another succumbs to the transfer of duties to the Central Government. If this reasoning is valid, it is difficult to discover any local function which is not of national interest or import.

In reality, solid waste disposal, as all other municipal functions, poses a fiscal problem, as well as a significant technologic problem. Some communities handle the function well, others poorly. Generally, cheapest methods are used first—the open burning dump. Then the community moves to controlled landfill, then to incineration and the like. The progress is clear, slow, and dollar motivated.

Whether the intrusion of Washington will engender a permanent increase in local resident consciousness and conscience remains to be

demonstrated. Whether it will produce more rapid technologic answers than those normally developed in the past likewise remains to be shown. At any rate, it is worth trying this additional route for research and development if for no other reason than to rescue this field of activity from low public interest and equally low technologic progress.

Of the major contributors to air and water pollution, solid wastes are proportionately the least significant. Present methods of disposal of the solid wastes of society are too often aesthetically objectionable or undesirable. Present legislative acts are calculated to upgrade public opinion and official behavior, by providing more for research and development in science and technology.

As in the other pollution issues hitherto discussed, the same unverified assumption is made in the present category of problem as in the previous ones, namely:

> This is a challenge which State and local governments cannot meet without assistance from the Federal Government. The handling and disposal of solid wastes are costly operations that strain the resources of State and local agencies (refer to committee report on clean air of 1965, p. 7, 1965).

No evidence to justify this broad statement appears in any of the testimony. Thousands of public disposal units in the United States are locally financed and operated. That more do not exist or are not improved is due to local acceptance of the status quo, to disinterest in aesthetic values, to lethargy, and to the normal behavior of officials and citizens pressed for many other public expenditures. Are all these to be cured by Federal legislative fiat and money? Or are we warranted in assuming that research in solid waste disposal under Federal stimulation and aid will disclose better and more economical procedures and practices than we now have? Let us look at the nature of the problem.

The annual output of urban solid wastes, containing such things as paper, grass and brush cuttings, garbage, ashes, metal, and glass has been estimated as 1,600 pounds per capita or over 125 million tons each year. The collection and disposal costs approximate between $2.5 and $3 billion a year.

No easy answer to either collection or disposal has so far appeared. Early efforts at salvage or recovery of materials have gradually given way to high-temperature destruction, as organic constituents of garbage were drastically reduced by refrigeration and modern packaging and as markets dwindled for grease, low-grade fertilizers, mixed metals, and glass. Easy answers in composting have not materialized sufficiently to offer simple and economical solutions to most urban areas, where increasingly long-haul collection costs to central disposal points are becoming prohibitive.

Most of these problems wait for solution upon scientific and technologic inquiry, by the combined forces of public and private agencies. The delusion that urban solid wastes represent a hidden "gold mine" of recoverable materials still awaits realistic demonstration.

A similar lack of realism characterizes the current solution of regionalizing solid waste collection and disposal—as if this were purely a semantic rather than an economic problem. In many instances, handling the issue upon a regional basis becomes a com-

pletely uneconomical solution because of excessive transportation costs. In any event, simple answers wholly unrelated to any factual demonstration should not blind us to the complex task confronting us with urban solid wastes.

The deep-seated problem of these wastes lies in the fact that the producers of consumer goods, as far as is apparent, have rarely if ever given a thought to the residual wastes which their products inevitably create. The time has arrived when this linkage between producer and disposer must be forged—or else society will be submerged in the byproducts of all the attractive materials, foods, and equipment which it now only partially consumes. The rest is consigned to the public official, to the nearest roadside heap, swamp, park, valley, or highway borrow pit. The listing of these byproducts of modern living are impressive. Each of them should pose a challenge to the producer. The official responsible for disposal should not be left alone "holding the bag" literally and figuratively.

Scrap iron and steel are generated at a rate of 12 to 15 million tons a year. About a third of this is in derelict automobiles. The amount of these being recovered is declining substantially. Salvage of other metals is still relatively high.

Paper products reaching the market annually are of the order of 30 million tons. About a third of this is salvaged to make new paper. Some 15 percent only of rubber products are reclaimed—approximately 260,000 tons.

The case of plastics poses an increasing problem in disposal. Of the 8 billion pounds produced each year, only 10 percent is recovered.

To these astronomical amounts we must add each year 48 billion cars, 26 billion bottles and jars, 65 billion metal and plastic caps, and a vast array of other packaging materials—virtually all of which, after use, lands in the lap of the refuse collector.

In searching for escapes from this dilemma of society, several avenues of attack must be opened. Some effort must be expended to match the technology and imagination of the producer of the sources of urban wastes in the area of disposal. Secondly, the producer must devote increasing attention to the disposal implications of the long list of things he sells. Thirdly, more satisfactory and economical processes for disposal and recovery must be developed.

One does not often include the farm in discussion of solid waste problems. Yet, the accumulation of the excreta of farm animals has become an acute issue in many areas. The mass production of poultry and waste resulting from the large feedlot finishing of beef cattle are additional examples of situations, where it is sometimes assumed that rural areas are free from waste difficulties.

In similar fashion, mining presents solid waste disposal issues of great magnitude. One estimate indicates that in 1963 more than 3.3 billion tons of waste rock and mill tailings were discarded near mine sites. In other collateral operations, mountains of slag, ash and other waste materials attest to the industrial activity of our country as well as to unresolved problems of waste disposal management.

It should be reasonably clear that not all of these solid wastes can be either collected, disposed of or salvaged in the same way. Their amounts, their diverse character, their potential value and their places

of origin indicate the wide spectrum of problem and the consequent necessity for broadly based research and development. Subsidy for collection and disposal will not provide the long-term answers so universally missing.

Report of the Environmental Pollution Panel (the Tukey Report)

(President's Science Advisory Committee)

In November 1965, the White House issued the above report. It is the most recent documentation of the problems and proposals in the general field of pollution of the environment. Its title reveals the temper and objective of the committee responsible for its preparation "Restoring the Quality of Our Environment." The environmental pollution panel was headed by John W. Tukey. The list of its membership and its advisers is a veritable who's who of distinguished and experienced scientists and technologists.

The report is perhaps the best exposition now available of the problems, the solutions and the unknowns in the pollution field. It is orderly in treatment, matured in judgment and surprisingly free of propagandistic "crisis and alarm." The basic definition upon which the document is predicated is long overdue, namely, that "Environmental pollution is the unfavorable alteration of our surroundings, wholly or largely as a byproduct of man's actions, through direct or indirect effects of changes in energy patterns, radiation levels, chemical and physical constitution, and abundances of organisms." Ingredients of the definition may well be spelled out in the objectives in abatement of pollution of water, air, and soil both in legislation and in administration.

The declared position of the Panel is best stated in its own words:

> Present levels of pollution of air, water, soils, and living organisms are for the most part below the levels that have been demonstrated to cause disease or death in people. * * * Prudence and self-interest dictate that we exert ourselves not only to prevent further building of pollutants, but to reduce present burdens of pollution in our air, our waters, and our land.

The volume carries an abundance of earthy wisdom as to what we do and do not know, as to the complexities of control procedures at various levels of government, as to what standards we are shooting for, at what price, and what intelligent and imaginative management will require in all kinds of skilled manpower.

The report should be read from cover to cover. Full recognition of the clarity of reason and statement will be best fulfilled by such a reading. The recommendations, covering principles, actions, coordination and systems studies, baseline measurement programs, development and demonstration, research, and manpower, should be required homework for congressional committees, administrative agencies, and policymakers. They should serve as a sourcebook for national activity for probably the next 5 years. Little significant exception may be taken to most of what is encompassed within pages 16 to 38, inclusive.

Specifically, little is said in the report regarding either money or current Federal administrative policy and practice—issues which are

distinguished in almost all other documents, as well as in this one, by their absence. It may well be that the Panel chose to disregard these two problems as outside their purview.

On the more positive side, one should underline the three recommendations:

B–26—Efforts be increased to establish the scientific bases upon which standards of environmental quality can be set.

C–1—The establishment by the National Academy of Sciences-National Research Council of an "Environmental Pollution Board."

D—The establishment of baseline measurement programs.

Mr. DADDARIO. And I would also like unanimous consent that a statement I had prepared to close these hearings also be placed in the record. If there is no objection, that will be done.

(The statement referred to follows:)

REMARKS OF CONGRESSMAN EMILIO Q. DADDARIO AT CONCLUDING HEARING IN WASHINGTON ON SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT ON POLLUTION ABATEMENT TECHNOLOGY

Today's testimony concludes this phase of the subcommittee's inquiry. I believe these hearings have accomplished our objective of illuminating the level of development in pollution abatement technology. I appreciate the contributions of our many excellent witnesses and the interest and diligence of subcommittee members.

The record requires careful and thoughtful study as to its implications for further research and development and also as to the time table for installation of presently available processes and equipment. Certain preliminary conclusions are apparent to me at this time.

First, we have heard that the lack of information on complex relationship among living things with their demandings makes it extremely difficult to set goals for the quality of the environment. In many cases, the risk to our welfare, if not also to our health, cannot be adequately evaluated in comparison to the benefits of using air and waterways for waste disposal.

These uncertainties are barriers to progress in pollution abatement and increased knowledge through research could do much to remove them.

Second, the cost of catching up in pollution abatement, and of keeping waste management up to date, will be in the order of $100 billion spread over the next 10 to 20 years. Continuing costs of operating treatment plants and devices will run to several billion dollars each year. We have seen a recognition and acceptance of these costs which have been absent before in the United States.

These large expenses suggest an immediate opportunity for research and development on a more economical means of abatement. The need for more efficient technology is urgent because in many instances we cannot and should not delay in corrective action. To some extent, it may be wise to divert a portion of expenditures from implementation of present technology to the development of better technology.

Third, the science and engineering resources of private industry will be necessary in developing new and improved technical approaches to pollution control; both to solve internal waste management problems and to serve a growing market for abatement equipment. The private sector laboratories are more likely to contribute meaningful and timely results if the Government can move forward in setting realistic criteria for air and water quality. But we see that this leads us in a full circle back to the ecological uncertainties which I mentioned as a first point.

Thus, it is clear that the persent research effort in environmental pollution is inadequate. To guide us beyond the immediate abatement of gross and obvious contamination, we must seek every means of accelerating the acquisition of more knowledge.

It seems to me that our national goal is really twofold. These closely related objectives are concisely phrased in the titles of the landmark reports which we

have learned so much about in the past few weeks. I can think of no better words for the goals than "Restoring the Quality of Our Environment" and "Waste Management and Control". There is a great challenge to the scientific and engineering community in these phrases. I urge all of us to be imaginative and bold in meeting this challenge.

Mr. DADDARIO. Dr. Wolman, I thank you for a very thoughtful presentation. Again I want to call to everyone's attention how helpful you have been to us, and second Mr. Conable's request that you will be working with us as we proceed from this point.

Dr. WOLMAN. Thank you, sir.

Mr. DADDARIO. This committee will adjourn to a time and place to be determined by the Chair.

(Whereupon, at 12:17 p.m., the subcommittee was adjourned.)

THE ADEQUACY OF TECHNOLOGY FOR POLLUTION ABATEMENT

MONDAY, SEPTEMBER 19, 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 a.m., in the auditorium, Old State Building, 217 West First Street, Los Angeles, Calif., the Hon. George E. Brown, Jr. (acting chairman of the subcommittee), presiding.

Mr. BROWN. This is a special meeting of the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics.

We are here this morning to hear a previously scheduled witness and, if we have time, further witnesses who may choose to appear or submit statements.

This morning we have Dr. Haagen-Smit, Mr. Louis Fuller, from the Los Angeles County Air Pollution Control District, Mr. Eric Grant, from the State Motor Vehicle Pollution Control Board, and Mr. W. L. Rogers from the Aerojet-General Corp.

Before we call Dr. Haagen-Smit, I have a brief opening statement which I will read, and then we will proceed with the testimony of the witnesses.

I am pleased, along with my colleague, Mr. Bell, to bring this field hearing of the Subcommittee on Science, Research, and Development of the House Science and Astronautics Committee to Los Angeles. Our chairman, Mr. Daddario, was most anxious that the record include testimony from today's witnesses which was not available to us in Washington because of the recent airlines strike and limitations of time there.

The thrust of these hearings is to review the state of the art in pollution abatement technology. We want to know where the competence is available to move ahead with capital investment and also where our present ignorance dictates the diversion of funds to move research and development.

Several committees of the Congress have been instrumental in implementing the growing public consensus for action in restoring the quality of our environment. The activities of our committee are complementary in that we want to make sure that American science and engineering are supporting the newly expressed goals and timetables.

So far, our studies have shown that the key to pollution abatement is proper waste management. In other words, our society is a using,

not a consuming, system and we have only recently recognized that there are no free or even cheap disposal routes for wastes and byproducts. Some pollutants must be eliminated at the source. Others must be recycled for further use. Still others must be safely conveyed to ocean depths, deep wells, or similar perpetual storage.

Los Angeles represents a unique and illustrative focal point of our hearings. The air pollution problem has equaled the cinema and orange grove in spreading our name. But also, this area is recognized as the greatest concentration of scientific and technical resources in the world. These resources are essential to practical pollution abatement, even more so than institutional and economic innovations. Wastes will always be with us, and their more efficient management is a direct benefit to our welfare, beyond the elimination of gross and obvious pollution.

So here we are with the problem in its most obvious and concentrated form. And here today are leading proponents of the technology to deal with it. The committee is anxious to hear specifics on how research and development can give us new and improved tools to meet the challenge.

Mr. Bell, would you care to add to that?

Mr. BELL. There is not much I could add to what you said, Congressman Brown. However, I want to point out that we are looking at the situation as it presently is, and also the future possibilities of developing of some kind of methods of waste abatement.

I was interested in hearing from one of my friends about a scientific meeting that occurred in one of the hotels up north in which one of the scientists indicated as he spoke that the water in that hotel really was only needed for purposes of drinking water; that a person actually doesn't need to use water for a bath—they could use some kind of power that would clean the skin—and the waste disposal could be handled by some kind of chemical recycling, and so forth.

These ideas that may appear to be way out, I think, bring home the importance of why we are here in Los Angeles. The aerospace industry here is deeply involved in studies of this kind for the future, and also, of course, the problem of our pollution right here in Los Angeles. I think that further and deeper research could develop into some kind of proper waste management.

Mr. BROWN. Thank you, Congressman Bell.

Our first witness this morning is Dr. A. J. Haagen-Smit, who is probably the best known name in the field of air pollution research.

Dr. Haagen-Smit, would you take a seat here? I want to say a few nice words about you before you start your testimony. I think all of us are well aware of the contribution he has made. I like to recall it was, I think, more than 10 years ago that I first called on Dr. Haagen-Smit for advice and counsel when I was serving as mayor of the city of Monterey Park, and we were considering solving the smog problem of fumes emitted from gasoline stations.

I am sure now we wouldn't have solved the problem had we not had the benefit of Dr. Haagen-Smit's counsel at that time on these problems. I have since read with great pleasure his increasing contribution to this field.

Dr. Haagen-Smit.

STATEMENT OF DR. ARIE J. HAAGEN-SMIT, CALIFORNIA INSTITUTE OF TECHNOLOGY

Dr. HAAGEN-SMIT. Thank you, Mr. Brown and Mr. Bell. Gentlemen.

The problem is a very large one, as you have pointed out. I would like to discuss briefly a few sections of that general problem.

I sent in a brief statement to Washington, and I will follow this closely.

In the first place, I would like to talk about stationary sources of pollution and then about moving sources, the automobile, naturally. Then about the efficiency of the different methods that are available now. Then I would like briefly to mention some of the criteria that we have to establish to see how far we have to go, what decisions we have to make between economy and between the health of the people.

Now, my statement that I sent to Washington started out with this sentence, "The nationwide application of existing methods of air pollution control would go far toward cleaning the air of most of our cities."

Now, this is not contrary to what you are trying to accomplish. The only thing that I want to express here is that most of our cities would be greatly benefited by the application of existing methods. We can mention quite a number of cities all over the country that would be greatly benefited with ordinary engineering methods and with existing dust collection and fume collection methods.

This, however, doesn't take away the fact that we have to refine our methods. The increase in the population, and the increase in the urbanization demands more and more technical skill to accomplish what we want to do.

I was most impressed about 2 years ago to see in the New York World's Fair what they call a demograph, which showed how many people were being added to the United States. A light flashed on when somebody was born every 7½ seconds. Every 17 seconds somebody died. So you have an excess there. Every 12½ seconds there is an extra person in the United States.

As you know, when you divide that into the number of seconds that there are in a year, you will see that easily amounts to around 10 million people. So we have to work hard to keep up with just the growth of our population.

Now, Los Angeles has dealt quite well with its stationary sources, as you will undoubtedly hear from Mr. Fuller. We had here some rather ugly problems in the metals industry, the steel factories—two large steel factories—some 120 foundries, and, of course, we had a number of large refineries. All of these have been controlled.

If we go to the area of Torrance, Dominquez, and in the southern part, such as Vernon, there is the difference between day and night compared to when we started in 1950. As a matter of fact, the real estate development in that area—in the Inglewood area and Rolling Hills area—would not have been possible without the control of the stationary sources which have been taken care of by the air pollution control district.

While it might cost a little, the financial advantages of the control are so great that we could easily spend much more than is being

done presently. If we divided the amount of money that is spent all over the country, it amounts to only about 30 or 50 cents per individual per day.

Now, we are talking here only about material advantages. There are many of us who believe there are some other advantages in our health. We began to believe also that we have a right to the enjoyment of life. It isn't just that we have to watch out for being sick, we also want to enjoy life when we are healthy.

This means that we have to have much greater control than we have at the present time.

Now, as I said, we have good control in Los Angeles, but as there is an increase in population we will have to control further.

Now, in the dust field we usually control the larger particles, but for every large particle that we catch, there are millions of very small ones that escape into the air. You don't see them, but they find their way in your lungs. There is no barrier for them and there is a general belief now by the medical people that this might have adverse effects.

So the methods that we do have, such as the electrostatic method, do not trap these small particles.

Here is a field of development that needs the best brains of the country, and we should spend considerable amount of effort in that direction.

Then, of course, we have the old problems, such as sulfur dioxide. We have solved this problem, to a very large extent, here in Los Angeles by the use of natural gas during the summer months, and as a matter of fact, even longer. First, we had only 7 months of gas use. Recently, through the action of the Los Angeles Air Pollution Control District, another 100 days was added to this 7 months. Those are the worst smog days.

Of course, there are other cities that want gas and would like to have a share of the cleanest fuel that you can use. Thus there will be more and more competition, and more and more people that want more and more power. When we see the program of power expansion, then you begin to worry a little bit. You say, "Well, what do we have to do? What about those small particles? What about sulfur dioxide?"

Several methods are under discussion. One of them is, of course, to locate the power production source outside this basin. There is also nuclear energy, but here too new problems arise. They are not the type that you can see, such as one can see dust and soot. But there is small atomic radiation, and we might have to go to refined methods. This development of nuclear power should parallel the developments of methods to eliminate any possibility of release of noxious compounds.

Then, we have the automobile here in Los Angeles as a major source that still has to be cleaned up. It isn't only Los Angeles which is plagued by this problem. There are other cities too that may not have the problem as frequently as we have. I believe that the California State Health Department determined that about 75 percent of the time, people complained about smog here in our area. Up north, it is only about 40 percent, but still if you complain 40 percent of the time, that is still too much.

I have been in New York when there was smog, and in Chicago where the smog has the typical odor of the Los Angeles smog. I also smelled it in Philadelphia and in some European countries.

So we need to put all our resources behind solving the automobile problem.

Now, as you know, there is work going on in the automobile industry in Detroit. There is work going on at several of the universities, but a great deal more has to be done. The State motor vehicle pollution control board has done a good job in getting the people to work and set criteria and standards, but these criteria and those standards will have to be stricter and stricter, because of the increase in the number of people.

I think we have not yet found a satisfactory solution to the automobile combustion problem. Maybe the current devices will tide us over. I think it is good that we have devices, such as air injection and the Detroit packages, but more has to be done. There isn't any doubt about that.

I would like to mention in this connection that I feel that not everything should be left to Detroit or the local community. When Detroit is asked for inspection of cars, that was a reasonable demand. We ask the same from the individual. Why shouldn't the individual go through a reasonable inspection of his car?

Then there is a great deal to be gained by measures which can be adopted in the local area. This is difficult, I realize. We have here 76 different governmental organizations which have to get together on just a common pattern of traffic.

This morning it took me three quarters of an hour to come down to this meeting, and it was only 12 miles.

I think some improvement could be made without too great difficulty, if we do some thinking about this. Now, I think I have said enough about this technical part. You will hear more about that from Mr. Fuller.

I would like to mention something about instrumentation. This is a field where a great deal of work has to be done since we must measure to control. The Air Pollution Control District monitors our air so that people have the certainty that they are not being subjected to lethal concentrations of pollutants. This is good and it works very well.

But in judging the control of automobile exhausts, we need instruments to measure, and in this field a tremendous amount of work has to be done. Its complexity gets greater and greater.

This is not only true with air pollutants, such as ozones, carbon monoxide and a few others, but also with agricultural chemicals which are extremely complex, such as 24–D, for example. This problem is going to be extremely complex, and this is where we need a great deal of development.

There is one other thing that I would like to mention, and that is the criteria on which we base our control methods. We must have criteria. There are some people that want nothing in the air except nitrogen and oxygen and carbon dioxide for the plants. There are others that say a little carbon monoxide won't hurt you, but in between there must be a basis found for a technical solution.

Now, the fact is, we do not have a community criteria for any single automobile pollutant. This might come as a surprise to many people because many of those compounds have been around a long time. Sulfur dioxide has been around for a long time. So has carbon monoxide, fluorescein, and ozone, but we do not have criteria for a community.

What we have is criteria for an industry, but industry criteria is completely different from a community criteria. If a fellow works in a factory, and doesn't like the smell, he can still find another job. In a community, this is a completely different thing. This man is going to live here, and he is not going to go because he doesn't like the smell.

There is one other item and this is the question of statistics which is very difficult in the case of a community. We say as a standard that only 1 percent, 10 percent, or one one-hundredth of a percent of the people will be bothered but when you calculate what one one-hundredth of a percent is in a population of 10 million people, that is an awful lot of people and an awful lot of complaints.

So it is extremely difficult to develop the criteria for a community. The kind of research we need there is preventive research. That is, we must study the physiological acts that appear when there is a compound in the air, and then see when the first changes begin to occur. These begin long before a man enters a clinic or before he becomes drowsy. This is the type of work that has to be done on a very large scale.

As I said, there isn't any pollutant for which we have at the present time that kind of a figure. For example, the industrial level for carbon monoxide is somewhere around a few hundred parts per million. The California State Health Department has accepted the level of 30 parts per million. At 30 parts per million, 5 percent of your blood hemoglobin is taken up by carbon monoxide, instead of oxygen. That is nothing serious. But the smoker inactivates another 5 percent, so together that is 10 percent.

The judgment was made that 10 percent of the hemoglobin inactivated might be acceptable, but who determines whether it should be 5 or 10 percent? At a matter of fact, I don't like to have the court determine that I am all right with 5 percent of my blood hemoglobin inactivated.

I don't like to have inactivation at any time. So here is where a tremendous amount of work must be done by the people in the universities, the different health departments, and everywhere you can find competent people.

Thank you.

Mr. BROWN. Thank you, Dr. Haagen-Smit. Your testimony has certainly covered the gamut of problems that exist in the field of smog control and the necessary research.

I want to ask just one question to start off with, and then I will ask Congressman Bell for questions.

We are faced within the next year or so with a requirement for exhaust devices on automobiles, which even at a modest cost of $50 per automobile for 10 million cars produced a year would mean about $500 million, which of course will be paid by the automobile purchasers—by the taxpayers.

Do you feel in your opinion, we are justified in adding that amount of cost on the American automobile buyer at the present time, or do you feel a part of that money, say, 10 percent of it, could be better spent on additional research before we require mandatory devices?

Dr. HAAGEN-SMIT. Well, Mr. Brown, I have been through that procedure since 1947, when I first entered the smog field, and talked with you, if you remember. There was always the idea of putting things off and there is always this idea that we have a solution around the corner.

You hear of the electric car, you hear of all kinds of ideas. I am all for rapid transit. But, if we start digging now, you know we won't have a transit system by the year 2000, I mean a good one.

So my answer is to install the devices. Many figures are very misleading. I am a moderate drinker, I should say. My bill per year is probably around $50 a year.

Mr. BROWN. That is pretty moderate.

Dr. HAAGEN-SMIT. That is very moderate. You must admit that.

If I had to choose between leaving drink alone or having clean air, I like clean air.

Mr. BROWN. What you are saying then is that we should use the device, do the necessary research also, and if the extra money hurts, maybe do without tail fins, or items like that?

Dr. HAAGEN-SMIT. Every time I look at a car, I am surprised how much unnecessary stuff there is on it.

Mr. BROWN. I agree with that.

Congressman Bell?

Mr. BELL. Dr. Haagen-Smit, it is a pleasure to welcome you to the committee. I, too, think your statement is most informative and covered a big area.

One question, Dr. Haagen-Smit. Should more of the NIH research be directed toward community hygiene problems, rather than well defined diseases, such as cancer, heart, and so forth?

Dr. HAAGEN-SMIT. No, I wouldn't make a choice there. We are rich enough to afford both and, as a matter of fact, there is overlapping, you know.

There are quite a number of substances which have pathogenic effects which might lead to cancer, so there is an overlapping. I think that a solution to those problems and then the criteria that will have to be established will come from both sides, that is, the study of cancer for cancer's sake, and the study of the effect of those minute substances in the air.

Mr. BELL. In other words, the studies should not affect each other in any shape or form; you should study both the hygiene problem and the cancer and heart problems?

Dr. HAAGEN-SMIT. There is no reason at all to let it interfere.

Mr. BELL. Do you see adequate cooperation within universities in research programs and training and control? In other words, do the departments of chemistry, biology, sanitation engineering, and so forth all plan a program together, or is the research fragmented in some way?

Dr. HAAGEN-SMIT. I think that it is most often fragmented, but then I think that is probably due to the peculiar nature of professors, rather than a feeling that they should not cooperate.

However, there is cooperation. There is no doubt about it. We have at our Institute, Dr. McGee, who is heading the environmental pollution group. His interest is mostly in water.

We have also Dr. Fredamalather, who is specifically interested in the deposition of material in air. So this is an air pollution problem. He talks freely to his colleagues. There is no doubt about it.

If you mean is there a tendency to form a united group, I think that in most cases you will find this absent.

Mr. BELL. In other words, you are saying there could be more cooperation.

Dr. HAAGEN-SMIT. There could be more cooperation, but I think that the Federal Government has done a very worthwhile job in given training grants to the different universities.

I know of about 10 of those different groups across the country, at Harvard, South Carolina, Virginia, and a few other places. A staff member is added to the existing group of people, and he then organizes a unit on environmental hygiene.

Mr. BELL. Dr. Haagen-Smit, in the broad picture do you think there is a lack of skilled manpower on management techniques in the pollution abatement industry?

Dr. HAAGEN-SMIT. Oh, yes.

Mr. BELL. You think there definitely is?

Dr. HAAGEN-SMIT. That report that we wrote, "Restoring the Quality of the Air and Environment," which was issued by a Presidential Panel, has so many quotations and chapters on the manpower requirement. Is there any doubt about it that we must have more men? The question we discussed in this report was where we could get this manpower.

Mr. BELL. Go ahead and comment on that.

Dr. HAAGEN-SMIT. There are several places where you can get those people.

First, of course, you have—let's call them the old ones, since I am old myself, I can call them the old ones—the ones that have learned the trade 25 or maybe 50 years ago. These should have retraining programs. I resented it when one of my colleagues said "retreading." What we are dealing with here is the introduction of new substances in the Los Angeles area. We have the photo industry enter the area, and the old smog inspector is, of course, at a handicap because he doesn't know anything about photochemistry.

The new specialists will learn about this. When insecticides, for example, get into the air, how do the older men cope with them? There should be a retraining, and this is partly done by the Federal Government—the Department of Agriculture, the Department of Health, and the Department of the Interior.

Then we come, of course, to the group that will take over from us, the new ones. This is where those Federal training grants come in, and they could easily be increased. We should have many centers where this training of modern air pollution control men take place. We should also have the funds that are necessary to attract people into this field, because it is very often forgotten that we buy our students now.

Mr. BROWN. Just like our football players?

Dr. HAAGEN-SMIT. That is just about right.

It is hard for some of us to get over this idea, but there are so many attractive fields. If you consider a boy at the beginning of his life who can work with Dr. Pickering (Jet Propulsion Laboratory) and design spacecraft for flights to Mars or Venus, while an alternative is to clean up the pollution problems from a powerplant, for example. The latter may be a very noble enterprise, but it doesn't appeal to the boy.

Now, money speaks a good deal and we must have the support of these fellows to want to go into such a field.

Mr. BELL. Thank you, Dr. Haagen-Smit.

I have one other question I would like to ask you.

Should the Federal funding of technological development stop at the proof-of-principle stage, or extend on to hardware prototypes and to demonstrations, and so forth? Where do you think the Federal Government's role should extend to in this particular area?

Dr. HAAGEN-SMIT. I don't believe that this answer can be given quite one way or the other. Let me give an example.

The Bureau of Mines has for many, many years done research on shale. After all, shale is not as valuable as coal, but we have lots of it; so a great deal of research went on, basic research. They also had pilot plants, because nobody else wanted to do it.

Now, if we leave this to the coal people, maybe something like that wouldn't happen.

I believe that in the automobile field, for example, some competition wouldn't hurt the automobile industry. I think that the work which is going on, for example, at UCLA, and at some of the oil companies on reducing oxides of nitrogen and also hydrocarbons is good. It was very good when outside agencies, the muffler makers, began to produce mufflers. By the time it was set to be put on a car, we suddenly found there were some other solutions, too.

I think we should always be in a position to have the funds and knowledge with which to cope with such a situation. So my answer is that there should be a certain competency in the Government organizations and at the universities to do certain things.

Mr. BELL. In other words, you do feel as far as the Federal and local governments and universities and industry, there should be some cost sharing in this program, too? I am talking about for research contracts.

Dr. HAAGEN-SMIT. The Federal Government, of course, should provide support as well as State governments. There is no reason why the industry couldn't support research, and they do, as a matter of fact.

There are brains in the university which may not be available to the industry, which may not be better but do represent different approaches. Some of the people in mathematics, physics, or chemistry might do better in the university atmosphere, and to draw upon their talents funds should be supplied.

Mr. BELL. Of course, we all recognize the difficulty in industry and in other areas, too. It is an additional cost to industry, basically, and I suppose from that standpoint you could say it would be necessary for some kind of cost sharing and participation of governmental organizations until we can get over the difficulties of the extra cost involved.

Dr. HAAGEN-SMIT. There is a certain extra cost involved, yes; but on the other hand, there are some advantages to be gained, too. So I don't feel too sad about the——

Mr. BELL. In other words, there may be created an incentive to free enterprise from the development of additional methods of selling programs?

Dr. HAAGEN-SMIT. That is a possibility; yes.

Mr. BELL. That is all.

Mr. BROWN. Thank you very much, Dr. Haagen-Smit. The committee has certainly benefited from your testimony.

If we have any further questions which we feel need to be explored, I hope you will allow us to send them to you in writing.

Dr. HAAGEN-SMIT. Thank you.

(The information requested is as follows:)

STATEMENT BY DR. A. J. HAAGEN-SMIT, CALIFORNIA INSTITUTE OF TECHNOLOGY

The nationwide application of existing methods of air pollution control would go far towards clearing the air of most of our cities. High efficiency dust collection electrostatic precipitators, scrubbers, etc., can take care of particulate matter and a variety of gases. There are, however, some noteworthy exceptions to this general statement. One has to do with the development of smog in large urban areas, such as Los Angeles, where automobile exhausts are a major cause of concern. Control methods have been applied but calculations of theoretical efficiencies coupled with practical considerations show that we must go further in control than is presently contemplated. This control includes hydrocarbons and their derivatives as well as oxides of nitrogen formed in the high temperature reactions between nitrogen and oxygen.

While it is true that efficient control methods exist for dusts, fumes and aerosols, and the efficiency is high for larger particles, smaller particles escape and remain suspended in the atmosphere. Our upper respiratory system is a barrier to the larger particles; the smaller ones which are not controlled readily reach the lungs. With our increasing urbanization and increasing pollution with small particles, ways have to be found to catch these and prevent serious damage to our health.

In all control work instrumentation is of great importance. One has to measure pollutant levels in the atmosphere and also the quantities emitted by various sources of pollution. There is a need for instrumentation which gives a continuous record and where price is of secondary importance. There is also a need for low cost analytical tools.

Control of our pollution is indicated when our health is affected or our senses are offended, when animal and plant life is affected, and damage to materials is seen. In each case the degree of control is a balance between technical feasibility and economic judgment. For control purposes it is of great importance to acquire the knowledge at what levels harm may be done. These criteria form the basis of legal standards for control. At present there are no satisfactory criteria for any one of the pollutants and a greatly accelerated program to acquire this fundamental knowledge for *any control program* is of prime importance.

Mr. BROWN. Thank you.

Our next witness is Mr. Louis J. Fuller. Mr. Fuller is the air pollution control officer in the Los Angeles County Air Pollution Control District, and in that capacity I am sure he has had considerable exposure to this problem.

We are happy to see you here, Mr. Fuller.

STATEMENT OF LOUIS J. FULLER, AIR POLLUTION CONTROL OFFICER, LOS ANGELES COUNTY AIR POLLUTION CONTROL DISTRICT

Mr. FULLER. Thank you, Mr. Chairman, Mr. Bell, and gentlemen.

I think the urgency of our situation here in Los Angeles would have been more apparent if the hearings had been held last Friday, rather than today.

Mr. BROWN. I arrived last Friday, and I appreciate your comment.

Mr. FULLER. I think I can also appreciate the position you gentlemen are in. You have a grave responsibility which I recognize.

I think further that you will also recognize that it is usual for any speaker or witness to recall a statement from some previous person which has some bearing. I would like to at this time make reference to a statement from one of the political giants of our American history, Thomas Jefferson.

He wrote that "men are inherently capable of making proper judgments if they are properly informed." That is what you gentlemen are seeking, I am sure.

Now, this presupposes, I am sure, that a witness is capable of giving you information which is proper and on which you can base sound judgments. I will try to do this.

I have prepared a statement here, but because of the atmosphere which has been generated by the testimony of Dr. Haagen-Smit, rather informal, I think I will depart, if I may, somewhat from my prepared statement.

Mr. BROWN. That will be very satisfactory.

Mr. FULLER. But in leading up to what I have to say, and a recommendation I would like to make for your consideration, I would like to discuss briefly the financial burden which has been borne by the county in the last 18 years.

The air pollution experienced during the late forties and early fifties consisted of about 40 percent emissions from stationary sources—industry and rubbish disposal—and about 60 percent of emissions from automobiles. Today, pollution from rubbish disposal has been eliminated, pollution from industry has been reduced almost to the practicable minimum, but pollution from motor vehicles has been controlled only slightly. We are making a tremendous inroad on this, and lest there be any misunderstanding in what I have to say, let me make this statement at this time.

I think that the efforts and the work that has been accomplished by the motor vehicle pollution control board and its staff since 1960 has been highly commendable. They are pioneering in a field in which there was resistance, and what they have accomplished I think constitutes the highest type of public service. They are to be, in my opinion, congratulated for the efforts they have made.

At present, control measures now in effect are keeping a total of 6,185 tons of pollution out of the air of Los Angeles County every day. Of these 6,185 tons, 5,085 tons are controlled as the result of the steps taken by the air pollution control district in regulating stationary sources. The other 1,100 tons are being controlled by the installation of crankcase and exhaust control devices.

Still uncontrolled and being emitted are pollutants totaling 13,730 tons per day. Of this, 1,310 tons come from all stationary sources including not only industry, but all combustion processes such as domestic heating and cooking as well. The other 12,420 tons are being emitted from motor vehicles, meaning for the most part from the exhaust pipes of gasoline-powered automobiles.

That is the balance sheet: 6,185 tons controlled; 13,730 tons uncontrolled. That which can be controlled from nonmoving sources has been almost completely controlled; that which can be controlled

from automotive sources has scarcely been touched and makes up 90 percent of our problem.

The cost to control 5,085 tons of pollution from stationary sources has been at least three-quarters of a billion dollars. Some of this we can measure with exactness, the remainder we can estimate. For example, a permit must be obtained for every piece of air pollution control equipment installed in Los Angeles County, and we keep a precise record of the cost of this equipment. Our records show that industry has expanded more than $130 million for such control equipment. This does not include, however, the cost of maintaining or operating this equipment, or the value of the land it occupies, nor does it take into account the cost of designing and building into other basic equipment the modifications necessary to meet our requirements without use of separate control devices. Wherever this is possible, it is done. The true cost to industry may be twice the $130 million. Another item which we measure precisely is the amount paid for fees for these permits, and the amount paid as fines for convictions of violations of our rules. Since 1948 these two items amount to $2,875,000. We also know accurately the cost of the air pollution control district for the 18 years of its existence: $42,530,000. Of this amount, more than $6 million have been spent for basic research. In addition, however, Los Angeles County taxpayers have also borne a pro rata share of the air pollution expenditures of the State of California and of the Federal Government; and that is a sizable amount.

Another area of expense has been rubbish collection and disposal, which costs an estimated $55 million a year in Los Angeles County. Since 1957 this has amounted to $450 million.

All of this expenditure for control is only the top of the iceberg of the cost of air pollution. There is no way of knowing the full cost to Los Angeles County over the past 20 years, but we can make an estimate. President Johnson has given the Federal Government's estimate of the cost of air pollution to the Nation as $11 billion each year. Los Angeles County represents about 5 percent of the national market, and if we assume that we share the national air pollution cost in the same 5-percent proportion, then in 20 years we have suffered a loss equal to $11 billion.

Because the figure is so staggering, our inclination is to discount it, and then discount it again, but even so we must conclude that the loss has been tremendous. And that is without taking account of the loss of productivity due to the distress of air pollution, and the price of pain and suffering, impaired health, and loss of well-being for millions of people. Nor does it take into account the general friction and drag on the entire mechanism of society caused by the debate, and pulling and hauling over the problem; the deluge of billions of words printed and spoken about the subject; the legislative hours expended, and the cost in time and money of proceedings such as this very hearing. For example, the cost to the APCD of just two proceedings that have extended over the past 3 years have cost about a quarter million dollars.

Now, we have been fortunate, gentlemen, in receiving some high comments and accolades from the Vice President of the United States. I might quote a recent statement of his. He said:

The war Los Angeles is waging against air pollution is already a modern legend * * *. The experience of Los Angeles has shown that local government can control most sources of air pollution, if they will * * *. The skeptics would do well to take a close look at what you have achieved here.

Now, at this point, gentlemen, if I may, I will not read the rest of this statement, but I would like to hand to you a report on air pollution engineering in Los Angeles County.

Mr. BELL. Mr. Chairman, I move this be made a part of the record.

Mr. BROWN. Without objection, that will be made a part of the record.

(The report referred to is as follows:)

Air Pollution Engineering In Los Angeles County

(By Robert G. Lunche, Director of Engineering; Eric E. Lemke, Principal Engineer; Ralph L. Weimer, Air Pollution Engineer; Julien A. Verssen, Air Pollution Engineer; Louis J. Fuller, Air Pollution Control Officer; and Robert L. Chass, Chief Deputy, Air Pollution Control Officer, July 1, 1966)

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INTRODUCTION

AIR POLLUTION ENGINEERING IN LOS ANGELES COUNTY

Los Angeles County, the largest heavily-industrialized, semi-tropical area in the world, is afflicted with a serious and well-publicized air pollution problem. This problem is accentuated by average wind speeds of less than six miles per hour, and temperature inversions on more than 260 days per year, which restrict dispersion of the air contaminants generated by the activities of seven million people. Sunlight acting upon the mixture of contaminants in the stagnant reservoir of air induces the phenomenon known as photochemical air pollution, commonly called smog. This type of air pollution is identified by distinctive eye irritation, ozone formation, vegetation damage, rubber cracking, and reduction in visibility.

Non-meteorological factors have been contributing to intensification of the smog problem over the years. Since 1939 population has more than doubled, industry has expanded from approximately 6000 establishments to more than 20,000 in 1966, and automobile registration, gasoline consumption and fuels usage have increased sharply. The only influence opposing this growth has been the stationary source control program. Eighteen years of prosecuting this vigorous program in Los Angeles County has demonstrated that industrial operations can be compatible with clean air in a community with strict air pollution laws. This program also has shown that remedies now are available for most types of air pollution problems wherever they may occur.

The program has not been cheap. In addition to nearly two decades of expenditures by the District for research, engineering and enforcement, industry has expended during this same period 127 million dollars for the installation of new control equipment units and 882 million dollars for basic production equipment. The cost of the basic equipment has undoubtedly been increased substantially to insure that it will comply with the exacting standards of the District's Rules and Regulations. Moreover, although there are no descriptive figures available, sizable sums also are spent each year to operate and maintain both basic and control equipment. Records indicate the cost of air pollution control equipment averages 25 per cent of the cost of the basic production equipment, but without these controls, air pollution in this area would be very measurably worse.

Table I shows that this program is preventing some 5085 tons of various air contaminants from entering the Los Angeles atmosphere each day. Of this total, control measures of the petroleum industry are responsible for removing some 3425 tons. The prohibition of burning of high sulfur fuels accounts for another 535 tons. The ban on single chamber incinerators and open burning prevents another 605 tons from entering the atmosphere. The control of air contaminants from mineral and metallurgical industries accounts for another 420 tons.

Of the 5085 tons of various air contaminants now prevented from entering the Los Angeles atmosphere from stationary sources each day, 1195 tons are hydrocarbons, 1320 tons are sulfur dioxide, 1945 tons are carbon monoxide, 470 tons are aerosols, and 155 tons are oxides of nitrogen.

Table II compares the emissions of each category of industry from 1948 to 1966. As low as the industrial emission levels of 1966 are, however, the program will not be complete and a problem will still be present in future years until effective control over the last remaining major sources of air pollution in Los Angeles County are achieved. These sources are the gasoline-powered vehicle, which is the largest source of air contaminants, fuel oil burning and organic solvent usage.

LEGISLATIVE SUPPORT

The accomplishments of the Los Angeles control program are attributable to strict application of effective air pollution legislation. This legislation stems from the enactment of the basic State law in 1947 by the California Legislature. This act was Assembly Bill No. 1 and was added as Chapter 2 to Division 20 of the State of California Health and Safety Code.

This act established the machinery for the adoption of Rules and Regulations for the Los Angeles County Air Pollution Control District. The statute enables a District to enact new and more stringent prohibitions when needed and when essential technical information becomes available. Over the years this provision has been utilized as shown by the addition of 13 new prohibitions and many amendments to existing prohibitions. Each addition or amendment followed a thorough investigation of the emissions, pollution problems and control potential.

TABLE I.—*Contaminants prevented from entering Los Angeles County atmosphere from stationary sources in tons per day, January 1966*

Emission source category	HC and other organic gases	Aerosols	NO_x	SO_2	CO
Petroleum refining:					
Catalytic cracking	25	5			1,545
Storage	350				
Separators and sewers	105				
Blowdowns and relief valves	125				
H_2S absorption				885	
Others	90				
Petroleum marketing:					
Storage (exclusive of refineries)	5				
Bulk loading	50				
Service stations	14				
Petroleum production	225				
Total	990	5		885	1,545
Organic solvent uses	14				
Chemical:					
Sulfur and sulfuric acid				25	
Other	20	20			
Total	20	20		25	
Incineration	165	165	30	21	225
Metals:					
Nonferrous		75		3	
Ferrous:					
Gray iron cupola		7			175
Electric steel		20			
Open hearths		6			
Other		1			
Total		110		3	175
Mineral:					
Asphalt batching		25			
Asphalt roofing	3	2			
Other	1	105			
Total	4	130			
Combustion of fuels:					
Rule 62	1	25	125	385	
Rule 62.1	3	25	165	265	
Miscellaneous		15			
Total (rounded):					
Rule 62	1,195	470	155	1,320	1,945
Rule 62.1	1,195	470	195	1,200	1,945

TABLE II.—*Emissions of contaminants into the Los Angeles County atmosphere from stationary sources, 1948 and 1966*

[Average daily emissions of air contaminants, in tons per day]

	Hydrocarbons, other organic gases		Oxides of nitrogen		Oxides of sulfur		Carbon monoxide		Aerosols	
	1948	1966	1948	1966	1948	1966	1948	1966	1948	1966
Petroleum:										
Refining	450	55	7	25	30	38	570	90	8	4
Marketing	155	100		11						
Production	270	60		9						
Organic solvent uses:										
Surface coating	170	295							2	7
Dry cleaning	30	30								
Degreasing	35	100								
Others	75	95								
Chemical:										
Sulfur plants						35				
Sulfuric acid plants					15	30				
Others	25	60			1	1			12	8
Incineration	100	1	20	1	20		145	1	185	1
Metals				3		3	325	3	25	8
Minerals	2	1		6					4	7
Combustion of fuels:										
Rule 62	[1] 15	11	[1] 230	165	[1] 520	24	[1] 2		[1] 35	16
Rule 62.1		16		275		375		1		48
Miscellaneous										2
Totals:										
Rule 62	[1] 1,325	810	[1] 255	220	[1] 585	130	[1] 1,040	95	[1] 270	55
Rule 62.1		815		330		480		95		85

[1] In 1948, Rules 62 and 62.1 were not in effect. The losses indicated are daily averages for the year.

The statute also provided for a permit system, which in Los Angeles County requires approval by the Air Pollution Control Office prior to construction and prior to operation of equipment capable of emitting air contaminants. This permit system is one of the most effective means of preventing air pollution, and the provision for a construction permit has saved may companies the expense of installing and subsequently replacing inadequate control equipment.

Under other provisions of the State law, a quasi-judicial Hearing Board was established to hear petitions for variances and appeals from denials of permits. If the Hearing Board judges that the evidence and equities justify a variance, it determines the conditions, duration and extent that a variance from requirements are necessary and permitted. To obtain a variance, the petitioner must demonstrate that he is diligently following a remedial program to develop or install controls for the equipment involved.

PROHIBITIONS

The prohibitions contained in the Rules and Regulations of the Los Angeles County Air Pollution Control District are the most stringent anywhere in the world. They govern smoke, nuisance, particulate matter, sulfur compounds, combustion contaminants, dusts and fumes, open fires, incinerator burning, storage of petroleum products, oil effluent-water separators, gasoline loading, sulfur content of fuels, gasoline composition, animal reduction processes and gasoline loading into tanks. These prohibitory rules and their intents are:

Rule 50: Ringelmann chart.—Establishes the maximum permissible time and opacity limits for the discharge of any contaminant.

Rule 51: Nuisance.—Defines a nuisance.

Rule 52: Particulate matter.—Establishes the maximum allowable weight of discharge of particulate matter per cubic foot of effluent.

Rule 53: Specific contaminants.—Establishes the maximum allowable concentrations for the discharge of sulfur compounds and combustion contaminants.

Rule 53.1: Scavenger plants.—Specifies the conditions under which a sulfur scavenger plant may operate.

Rule 54: Dust and fumes.—Establishes the maximum allowable weight of discharge for dust and fumes.

Rule 56: Storage of petroleum products.—Describes equipment that can be used for the control of hydrocarbons from the storage of gasoline and certain petroleum distillates.

Rule 57: Open fires.—Bans burning combustible refuse in the open.

Rule 58: Incinerator burning.—Bans the use of single chamber incinerators.

Rule 59: Oil effluent water separators.—Describes equipment that can be used for the control of hydrocarbons from oil-water separators.

Rule 60: Circumvention.—Prevents the use of equipment which would tend to conceal the emissions of air contaminants without actually resulting in the control of air pollution.

Rule 61: Gasoline loading into tank trucks and trailers.—Describes control equipment that can be used for the control of hydrocarbons from the loading of gasoline into tank trucks.

Rule 62 and 62.1: Sulfur content of fuels.—Bans the use of high sulfur fuel oils in the Los Angeles Basin.

Rule 63: Gasoline specifications.—Prevents the sale of high olefin gasoline.

Rule 64: Reduction of animal matter.—Describes equipment that must be used to control odors from rendering operations.

Rule 65: Gasoline loading into trucks.—Describes the equipment that must be used to control hydrocarbon vapors from the loading of gasoline tanks.

It can be seen that the Rules and Regulations affect the operation of every industry, almost every commercial endeavor, and, in the case of open fires and incinerator burning, every homeowner in Los Angeles County. Through their enforcement, controls have been applied to such diverse sources and operations as incinerators, rendering cookers, coffee roasters, petroleum refineries, chemical plants, rock crushers, asphalt plants, open hearth furnaces, electric furnaces, automobile assembly plants, as well as less obvious sources such as restaurants, crematories, and housing tract developments. From the smelting of metal to the production of dog food, air pollution-prone operations have been brought within the scope of the control program.

ENGINEERING CONTROL EQUIPMENT

From April 1948 to January 1966, 66,756 permits for basic and control equipment were issued by the Los Angeles County Air Pollution Control District. During this same period of time, the Air Pollution Control District denied 5457 applications for basic and control equipmnet valued at $526,655,000. The approximately 12,000 air pollution control devices installed in industrial plants vary widely in cost and collection efficiency. The principal types used in the engineering control program included electrical, precipitators, baghouses, fume burners, centrifugal collectors, scrubbers and washers, vapor collection equipment, absorbers and adsorbers.

Electrical Precipitators separate and collect particulate matter from dirt-laden gas streams. The control device contains oppositely charged, high voltage plates and wires. The solid materials in the gas stream are given an electrical charge by the wires, and then are attracted to the oppositely charged plates. Periodically, the particulate matter deposited on the plates are "rapped" or washed off and collected for harmless disposal.

Baghouses collect particulate matter, and function much like the household vacuum cleaner. They contain a number of tubular bags made of glass fiber, felt, or similar material. Dirt-laden gas streams are vented to baghouses through inlet headers, which distribute the gas under pressure into the tubular cloth bags. The gas passes through the cloth, while the aerosol contaminants are filtered out and retained on the cloth. The filtered aerosols are removed from the bags by periodically stopping the gas flow and shaking the bags or jetting air back through the bags, allowing the material to be collected in hoppers and the bags to be restored to operating efficiency.

Fume Burners incinerate the combustible materials contained in a waste gas stream. These devices consist of a refractory-lined shell equipped with one or more natural gas burners. Sufficient time and temperature are most important factors in the ultimate efficiency of such devices.

Other Collectors and Separators commonly used to collect solid materials are cyclone separators and settling chambers. Cyclone separators employ the principle of centrifugal force to throw the solids out of the swirling gas stream, and function much like a cream separator. Settling chambers collect large solids by slowing the gas stream to permit heavy particles to settle out.

Scrubbers and Washers cleanse particle laden gas streams by use of a spray which strikes the solids and washes them from the gas. Gas also may be bubbled through a liquid bath for cleansing.

Vapor Collection Equipment captures vapors generated during the storage or handling of gasoline and other volatile products. The vapors expelled from storage vessels are conveyed through vent piping to collection equipment such as vaporspheres. The control system may compress and condense the collected vapors back into a liquid state, or may process them for removal by absorbers. In some cases, the vapors can be used to fuel boilers, and in other cases, they are incinerated in fume burners.

Absorbers employ a process in which a liquid dissolves a gas. They may be used to remove selectively one gas from another. Usually, absorbers are cylindrical towers which are packed with an inert material or equipped with trays or plates to increase contact area and efficiency of absorption.

Adsorbers employ a physical process in which the molecules of either a gas or a liquid are captured and held by a solid material. Activated carbon is a common adsorbent and has a large surface area available in the form of many very small capillaries to capture and hold gas and liquid molecules. The activated carbon very frequently is regenerated by steam which vaporizes the adsorbed material. A condenser returns the steam and adsorbed material to the liquid state.

CONTROL PROGRAM ACHIEVEMENTS

Each type of device possesses its own advantages and limitations. Each source poses different problems in terms of the volume, temperature, and characteristics of the waste emitted from it. In effect, a solution must be tailored to the source. The degree of control which a community requires will dictate, in the main, which type of control will be utilized and the cost of the control system. Concrete examples of contaminant emission reducing actions, many employing

the preceding devices, that have been effective in the Los Angeles County Air Pollution Control District's control program can be pointed out in almost every industrial activity.

Large crude oil tanks at petroleum pipeline tank farms and marine terminals are equipped with vapor controls, such as floating roofs. Wet gas from production fields is collected and processed in natural gasoline absorption plants and dry gas is compressed, where necessary, and sold or used as fuel. Vented thermal dehydrators have been replaced with electrical dehydrators to reduce hydrocarbons emitted through greater evaporation at the elevated temperatures.

Vapor emissions from petroleum distillate storage tanks have been curbed through enforcement of Rule 56, enacted in 1953. The first control measure of its type anywhere, this rule specified that all tanks greater than 40,000 gallons in capacity must be controlled when used for the storage of a petroleum distillate having a vapor pressure of 1.5 pounds per square inch absolute or greater. This one rule has resulted in a reduction of hydrocarbon vapor emissions of approximately 355 tons per day.

Attempts to control oil-effluent water separators began in 1953 and became effective with the enactment of Rule 59 in 1955. This rule prevents the emission of malodors and approximately 105 tons per day of hydrocarbons. Compliance with the rule is 100 per cent and, so far as is known, this is the only area of the United States in which controls for separators are required.

Visible evidence of technical progress in air pollution control in the petroleum industry is provided by the replacement or conversion of conventional flares to smokeless-type flares. One type of smokeless flare uses steam injection, another uses a series of venturi burners actuated individually or in groups by pressure increments. Since 1956, the operating controls of steam-injected refinery flares have been elaborated in an effort to make them capable of handling without smoking the largest release of vapors expected, even during disaster conditions.

Fluid catalytic cracking presents an air pollution problem because of the discharge of visible plumes, carbon monoxide, catalyst dust, hydrocarbons, and other air contaminants. In Los Angeles County, all fluid catalytic cracking units are equipped with approved dust collection equipment, such as electric precipitators, to control the catalyst dust. In addition, carbon monoxide waste heat boilers effectively and economically control discharges of hydrocarbons, carbon monoxide and plumes from these units.

Because of the limitations imposed by regulations of the District, and through the modernization of the refinery and petrochemical units, continued air pollution control improvement for process equipment has been realized. The last major vacuum jet discharge into the atmosphere in this area was controlled by incinerating the effluent vapors in a heater firebox. An estimated 450 pounds per day of hydrocarbon vapors from this one jet are now being used as a source of fuel. Mechanical seals on centrifugal pumps, manifolds for emergency relief systems to smokeless-type refinery flares, sealed drains, and controlled shutdown and startup procedures have further decreased the hydrocarbon emissions from such manufacturing operations.

Rule 61, which was adopted in 1956, requires that the hydrocarbon vapors displaced from tank trucks during their loading with large volumes of gasoline be collected and disposed of in an approved system. Approximately 50 tons per day of hydrocarbons now are prevented from being discharged into the atmosphere during loading operations by this rule. This is a savings to the industry. Gasoline loading is controlled in no other area and, in fact, the control technology was developed locally.

An additional 14 tons per day of hydrocarbons are prevented from entering the atmosphere by control of the filling of underground gasoline storage tanks from tank trucks, mostly in gasoline service stations. Rule 65, adopted in April 1964, prohibits the loading of gasoline into a stationary tank with a capacity of 250 gallons or more unless through a permanent submerged fill pipe, or unless the tank is equipped as specified in Rule 56.

The control of sulfur dioxide was one of the first major programs undertaken by the District after its formation in 1947. One of the first successful phases of this effort involved the control of sulfur dioxide from sulfuric acid plants, all of which now are operating in compliance with Rule 53a. This rule limits the concentration of sulfur dioxide in the effluent gases to a maximum concentration of 0.2 per cent by volume.

An important breakthrough in the overall sulfur dioxide program came with the commercial development of the Claus sulfur recovery process, and with the expansion of hydrogen sulfide extraction facilities in the refineries. The Claus sulfur recovery-process converts hydrogen sulfide into elemental sulfur. Refineries which previously burned their hydrogen sulfide in combustion equipment to sulfur dioxide now send this hydrogen sulfide to sulfur recovery plants.

In 1949, the first sulfur recovery plant constructed in this area began operation to produce elemental sulfur from the hydrogen sulfide extracted by four refineries. In 1950, two more refineries began recovering their hydrogen sulfide and trucking it to a sulfuric acid plant. Today, nine sulfur recovery plants are operated by or for refineries in the area and as of January 1966 were preventing emissions of 885 tons of sulfur dioxide per day.

Early in the Los Angeles County air pollution control program, it was determined that severe local nuisances and daily emissions of hundreds of tons of organic compounds and particulate matter resulted from open fires, single chamber incinerators, and burning dumps. These emissions contributed to local nuisances, visibility reductions, and other typical smog symptoms.

Soon after the activation of the Air Pollution Control District on October 14, 1947, action was started to prohibit these obvious and serious contributions to air pollution. The first abatement efforts of the District were directed at the open burning dumps. Injunctive actions brought against the dump operators proved very effective, and by the end of 1949, the open burning of refuse in all but one of the 54 dumps in Los Angeles County had been effectively eliminated. The last burning dump was eliminated in the following year. In 1955, Rule 57 was added to the Rules and Regulations of the District, prohibiting, with but few exceptions, the open burning of any combustible refuse in the Los Angeles Basin.

Efforts of the District next were directed to the elimination of more than one and one-half million domestic single chamber incinerators and several thousand of their inefficient industrial and commercial counterparts. On June 9, 1955, Rule 58 banned the use of all single chamber incinerators after September 30, 1957, the deadline date being fixed to permit the incorporated communities of the County sufficient time to provide for other means of refuse disposal. On March 14, 1957, the Board of Supervisors adopted Rule 58.1, which advanced the deadline for the ban to July 1, 1957, for single chamber incinerators at commercial and industrial establishments, as well as at multiple dwellings.

Those operations, which require the burning of combustible waste products, now can be conducted only in multiple chamber incinerators. Emission standards applicable to this equipment were tightened in 1958 so as to reduce allowable concentrations of combustion contaminants from 0.4 to 0.3 grains per standard cubic foot of gas at 12 per cent CO_2. Multiple chamber incinerators which meet this new standard decreased emission of combustion contaminants about 90 per cent compared with the operation of single chamber incinerators.

Refuse presently being burned in approved multiple chamber incinerators is principally from commercial and industrial establishments. There are also several large industrial incinerators, ranging in size from 500 pounds per hour to 6,000 pounds per hour, and designed primarily to dispose of wood, paper, and cellulose type waste material created by mass production industries. The number of multiple chamber incinerators constructed since the ban of single chamber incinerators has not been as great as expected. Instead, most of the rubbish formerly burned now is being hauled to sanitary landfill sites. In general, rubbish collection charges have decreased since the ban, and most commercial and industrial establishments find it more economical to use refuse collection services than to construct a multiple chamber incinerator.

Asphaltic concrete batching plants have been controlled in Los Angeles County with the use of water scrubbers. Most collection systems consist of simple cyclone, used as a precleaner, followed by one or more long, internally fluted cylindrical spray chambers in which the dust-laden gases are admitted tangentially at high velocities.

Emissions from concrete batching plants have been reduced by process changes and cloth filter devices.

Malodors are the principal air contaminants caused by inedible rendering operations. Noxious ordors are evolved from the handling and storage of "dead stock," packing house scrap, blood, etc.; but, by far, the largest ordor sources are heated rendering cookers and driers. It is generally considered that handling and

storage malodors are insignificant in comparison to those odors emitted from cookers and driers. Rule 64 was enacted in 1959 to combat noxious odors from inedible rendering operations. It requires, essentially, that all gases and vapors created in the heated reduction of inedible animal matter be incinerated at 1200° F, or treated in a manner equally effective for purposes of air pollution control. All rendering equipment is vented to adequate odor control devices as of this date.

Since 1961 the total quantity of feedstocks handled in local rendering systems has increased by approximately 40 per cent while reduction in total odor emission due to control measures has remained at better than 99 per cent. A quantitative measurement of odors developed by the Engineering Division has enabled the Air Pollution Control District to check constantly on the degree of control maintained by the rendering industry, and on industrial compliance with the standards specified in Rule 64.

Since 1959, nuisance complaints of rendering odors received by the Air Pollution Control District have decreased sharply. Where source identification has been possible these have been traceable either to malfunctioning of control equipment, to operator negligence, or to inadequate housekeeping practices. The exact quantity of odors exhausted to the atmosphere during these excursions is impossible to assess, but it is apparent that any one of the plants engaged in rendering operations is capable of producing more odors, if uncontrolled, than the total quantity of odors emitted from all Rule 64 control equipment combined. Under the impetus of Rule 64, and with guidance from the District, industry developed and placed in operation much original control equipment. As an example, the first unit in the U.S.A. to control odors from fish meal driers by mixing effluent gases with chlorine and scrubbing with sea water began in operation in May 1962.

Since 1948, metallurgical melting operations in Los Angeles County have been subject to vigorous air pollution control measures. Both ferrous and non-ferrous metal melting operations have been affected. Ferrous operations include gray iron foundries and steel foundries. Non-ferrous operations include foundries making castings of brass, bronze, aluminum, zinc, lead, and magnesium, as well as secondary smelters used in the recovery of these metals. Air contaminating emissions from metallurgical industry melting operations consist principally of smoke, dusts, and metallic fumes. Characterized by their extremely small particle size, control of metallic fumes emissions requires highly efficient collection equipment.

Four types of ferrous melting furnaces now operated in Los Angeles County include gray iron cupolas, reverberatory and open hearth furnaces, electric arc furnaces, and electric induction furnaces. Aerosol emissions resulting from cupola furnace operations consist of dust, smoke, and metallic fumes in varying quantities depending upon the materials charged. The voluminous opaque emissions from cupola furnaces were an air pollution problem which required early attention of the Air Pollution Control District. Detailed source tests showed the emissions to be in excess of weight limits as well as opacity limits. Enforcement and application of permit standards secured proper control of all cupola furnaces.

Since 1948, substantial increases have occurred in the total number of electric furnaces in use in Los Angeles County, and in the total tonnage of steel melted in those furnaces. From 1948 to 1953 the total tonnage of electric steel production increased greatly, even though the number of furnaces in operation remained the same. This resulted from the replacement of smaller capacity furnaces with larger ones. Since 1953–54, the reverse has occurred, with a substantial increase in usage of small capacity furnaces, having only a moderate effect on total production tonnage. Application of permit standards has insured that all electric steel furnaces operate in compliance with Air Pollution Control District Rules.

Currently there are over 400 companies engaging in non-ferrous metal melting operations. Over 100,000 tons per month of aluminum, brass, lead, magnesium, zinc and other non-ferrous metals are processed in approximately 1600 furnaces. Engineering estimates show that 75 tons of aerosol contaminants are prevented from entering the atmosphere on an average day and but three tons are emitted.

The main regulatory statute forcing pollution from all types of metal melting furnaces to be reduced to acceptable levels is Rule 54, which limits the weight of emission on a graduated scale corresponding to the amount of metal processed.

Vigorous application of Rule 54 has changed the industry from one of almost no control in 1938 to one of almost complete control in 1966, through the installation of over 300 devices consisting mostly of baghouses and electrical precipitators. Culminating this program, but by no means ending this period of achievement, is the placing in operation of a baghouse, the first installation of its kind to collect all emissions within a building containing steel melting and pouring operations. This major piece of air pollution control equipment has been constructed at a cost of over 1.5 million dollars.

ENGINEERING "FIRSTS"

In staying at least one pace ahead of the problem, the engineering control program has produced many "firsts" during the past eighteen years. The type of equipment and approximate costs involved are listed in Table III presented in the following pages. With the technological developments necessary to keep pace, even some of these "firsts" are no longer in use since better methods of solving the air pollution problem have been found and adopted.

Table IV gives a list of typical basic and control equipment installed in Los Angeles County over the past eighteen years. In some cases, the cost of the control equipment is but a small fraction of the cost of the production equipment. In other cases, the cost of control equipment is greater than the cost of the basic equipment.

TABLE III.—*Los Angeles County "firsts" in air pollution control*

Date placed in operation	Equipment	Cost in dollars	Remarks
January 1948	Exhaust system with baghouse serving brass melting crucible furnaces	4,000	First brass furnaces of this type to be controlled.
August 1949	Exhaust system and baghouse serving an electric steel melting furnace	2,500	First electric steel furnace ever to be controlled with a baghouse.
February 1950	Afterburner serving a coffee roaster	1,800	First coffee roaster ever equipped with afterburner.
June 1950	Afterburner for a varnish cooking kettle	2,000	First direct fired afterburner and the first really satisfactory control device on a varnish kettle.
August 1950	Exhaust system and electric precipitator with waste heat boiler serving an open hearth steel melting furnace.	150,000	First open hearth furnace to have satisfactory air pollution control equipment.
November 1950	Electric precipitator serving an aluminum dross recovery plant	30,000	First dross recovery plant ever controlled by a precipitator.
December 1950	Chemical plant to recover elemental sulfur from refinery waste hydrogen sulfide.	1,150,000	First chemical plant in Los Angeles County to recover waste hydrogen sulfide gas and convert to elemental sulfur.
January 1951	Exhaust system, quencher, and baghouse serving two iron melting cupola furnaces.	15,000	First iron cupola ever to be satisfactorily controlled.
February 1951	Baghouse serving a galvanizing kettle	1,000	First baghouse to serve a galvanizing installation.
May 1951	Water spray cooler and baghouse filter serving an asphalt roofing paper saturator.	25,000	First baghouse ever used to control oil mists from an asphalt roofing paper saturator.
January 1952	Electric precipitator serving an iron melting cupola	40,000	First electric precipitator ever used to control a gray iron melting cupola furnace.
Do [1]	Exhaust system with electric precipitator serving 2 75-ton and 1 50-ton electric steel melting furnaces.	650,000	First satisfactory installation ever to control large electric steel melting furnaces.
February 1952	Pease-Anthony venturi-cyclone scrubber	25,000	First ceramic frit smelter to be controlled satisfactorily.
April 1952	Exhaust system with afterburner and baghouse serving aluminum sweat furnace and a rotary aluminum chip dryer.	6,000	First really satisfactory installation ever to control such nonferrous operations.
February 1953	Water scrubber serving galvanizing kettles	12,000	First control device capable of controlling odors and gases from a galvanizing operation.
Do [1]	Boiler firebox and crude oil absorber serving refinery waste water system.	340,000	First controls for a refinery waste water system in which separator is covered and collected gases are absorbed or incinerated.
June 1953	Water scrubber coupled with electric precipitator for controlling fumes from fluxing of aluminum in a reverberatory furnace.	45,000	First such control system ever installed for the combined problem of fluoride and chloride fluxing fumes.
July 1953	Electrostatic precipitator serving an asphalt roofing paper saturator	40,000	First 2-stage electrostatic precipitator ever installed to control a roofing paper saturator.
November 1953	Water scrubber for control of fumes from airblown asphalt manufacture.	45,000	First installation ever to use a sea water scrubber.
Do	Sour water oxidizer to convert odorous sulfides into water-soluble thiosulfates.	30,000	First installation for disposal of sulfides in effluent water as contrasted to standard method of burning to sulfur dioxide.
December 1954	Absorber unit employing gasoline as the absorbing medium for recovery of vapors collected from bulk loading of tank trucks.	40,000	First installation of its type ever to be designed and installed.
Do	Vapor collection system for gasoline loading rack at refinery	30,000	First vapor collection system to collect escaping hydrocarbon vapors released in bulk loading of gasoline into tanker trucks at loading racks in refineries.
January 1955	Floating roof for effluent oil-water separator	250,000	First control of open effluent oil-water separator by covering the oil separation section with a rectangular designed floating roof.
April 1956	Direct flame afterburner on a paint bake oven	5,000	First paint bake oven equipped with a direct flame afterburner to control emissions.
Do	Direct flame afterburner serving meat smokehouse	4,000	First direct flame afterburner ever installed on a meat smokehouse.

October 1956	Baghouse with radiant cooling ducts on glass furnace	8,500	First installation of control system on glass furnace.
November 1956	Scrubber coupled with an electrostatic precipitator serving meat smokehouses.	10,000	First such control device ever installed to control smoke from smokehouse.
March 1957	System for control of discharge from coker unit blowdown, consisting of water scrubber, condensers and final discharge to refinery flare.	385,000	First system for control of hydrocarbons from coker unit blowdown.
October 1957	Exhaust system with baghouse serving four stereotype metal melting pots.	9,000	First such controls installed at a printing establishment to control metal melting operations.
January 1958	Direct fired afterburner serving plastic curing oven	2,800	First afterburner ever installed to control the discharge from a plastisol curing oven.
February 1958	Activated carbon adsorber installed to control solvent losses from dry cleaning plant.	4,000	First such installation for this type cleaning plant.
March 1958	Direct fired afterburner on a large paint-baking oven	16,000	First installation of its kind on an automobile paint bake oven.
Do [1]	Activated carbon vapor adsorber on a 5-color rotogravure printing press.	48,000	First regenerative activated carbon adsorber unit serving rotogravure press and which was installed strictly for air pollution control purposes.
Do	Activated carbon adsorber serving 47 paint-mixing tanks	10,000	First such installation made at an automobile manufacturing plant for the purpose of controlling solvents.
April 1958	Catalytic afterburner on paint bake oven in automobile assembly plant.	70,000	First catalytic afterburner installed to control paint baking oven in an automobile assembly plant.
August 1958	2-stage combustion modification of front-fired powerplant steam generators.	40,000	First application of delayed air entry, as a means of reducing oxides of nitrogen emissions from large oil-fired steam generators.
February 1959 [1]	Electric precipitator serving a 1,254,000-lb.-per-hour oil-burning steam generator.	1,000,000	First time any oil-burning steam generator has even been equipped with an air pollution control device other than controls for soot blowing.
June 1959	Afterburner for three silicone rubber curing ovens	2,000	Eliminates visible emissions.
July 1959	Cloth filter dust collector for dry batching of concrete	3,500	Cloth baghouse using a canvas hood.
September 1960	Sludge incinerator	23,500	Special designed incinerator that burns heavy ends from ethylene manufacturing facility.
November 1960	Direct-fired afterburner serving a phthalic anhydride manufacturing unit.	20,000	First direct-fired afterburner for a phthalic anhydride unit, as opposed to other units in the United States controlled by catalytic combustion units.
Do	Integral gasoline loading and vapor recovery arm	2,000	First commercial gasoline loading arm with integral vapor recovery line designed expressly for air pollution control of hydrocarbon vapors displaced during filling of tank trucks and trailers and equipped with positive safety features.
February 1961	Automotive bake oven for water-based primers	10,000	First in Los Angeles County for drying auto bodies coated with water based primers.
March 1961	Hydrocracking unit	530,000	First hydrocracking unit in Los Angeles County for producing low olefin content gasoline from diesel oil and heavy naphtha.
April 1961	Direct-fired afterburner for a can coating oven	37,000	First direct-fired afterburner to incinerate vapors from can coating oven operations. The heat from the afterburner is used to preheat incoming effluent.
Do	Activated carbon adsorbing device for a degreasing system	10,000	First activated carbon adsorbing device used to recover organic vapors from a degreasing system.
Do	Waste gas disposal system in a vinyl chloride operation	8,500	Waste gases are burned in a boiler with the gases scrubbed before entering boiler and after leaving the boiler.
Do	Automatic gasoline blending	1,100,000	Automatic blending of various gasoline stocks by means of electronic panels through pumps and valves with controlled loading to each truck.
March 1962	Baghouse to control emissions from ships' holds	5,000	Heated reverse air jet type baghouse controls emission from 2 transfer points and ships' holds during loading of dusty material.
April 1962	Continuous solvent extraction unit for rendered animal matter	200,000	First installation in the United States to continuously extract tallow and fats from rendered animal matter with a hydrocarbon solvent.

[1] Unit no longer in operation.

TABLE III.—*Los Angeles County "firsts" in air pollution control*—Continued

Date placed in operation	Equipment	Cost in dollars	Remarks
May 1962	Electric induction furnace to melt gray iron	45,000	First electric induction furnace to replace a cupola for melting gray iron.
Do	Chlorinator-scrubber serving a fish meal drier	50,000	First such unit in the United States to control odors from a fishmeal drier. Gases are mixed with dry chlorine gas and then scrubbed with sea water.
September 1962	Scrubber serving TCC unit	15,000	Fixed-type water-scrubber to collect catalyst dust. Replaces Roto clone, less maintenance.
October 1962	Control of sedimentation tanks in a water reclamation plant	1,525,000	Two exhausters vent covered sedimentation tanks through aeration tanks.
November 1962 [1]	Multiple-chamber incinerator for the burning of chaff from coffee roasting.	3,000	First multiple-chamber incinerator for burning of chaff. In the past, afterburners had been used to dispose of chaff.
February 1963	Bottom loading gasoline rack	14,000	First control of hydrocarbon emissions from bulk loading by means of a bottom-loading vapor collection system.
April 1963	Scrubber to control 13 ceramic porcelain spray booths	45,000	Scrubber has an air to water ratio of 25 to 1. 530 nozzles are required in scrubber.
March 1964	Baghouse on three rotary frit smelters	60,000	Baghouse handled 12,000 CFM at 200° F. Cooling train precedes collector.
June 1964	Flare system serving covered waste water separator system and dehydrator tanks.	2,500	Elevated flare operating without steam disposes of vented gas from system.
August 1964	Direct-fired afterburner for a can coating oven	25,000	Waste heat from the afterburner supplies all the heat required by the oven.
October 1964	Afterburner for two rubber grinders	3,500	Two rubber grinders in series grind scrap rubber. Formerly this operation created smoke and odors.
November 1964	Baghouse serving a grain loading facility	130,000	Grain terminal with controls on all grain receiving and loading facilities.
1965	Baghouse serving pouring floor emissions at a steel mill	1,400,000	First installation to collect all emissions within a building containing steel melting and pouring operations and to vent them to a baghouse. The emissions from the electric steel melting furnaces also controlled by the same baghouse.
	Baghouse serving a 2,200,000 pound per hour steam generator during oil fired.	1,000,000	First fabric dust collector to be installed at a power plant steam generator. A dry alkaline additive will be used to effect the filtration of sulfur trioxide, the major cause of visible emissions.

[1] Unit no longer in operation.

TABLE IV.—*Typical costs of basic and control equipment installed in Los Angeles County*

Source	Size of equipment	Cost of basic equipment	Type of control equipment	Cost of control equipment
Airblown asphalt system	500 barrels per batch	$10,500	Afterburner	$3,000
Asphalt concrete batching plant	200,000 pounds per hour	150,000	Scrubber	10,000
Asphalt saturator	6 by 65 by 8 feet	40,000	Scrubber and electric precipitator	50,000
Asphalt tile production	5,000 pounds per hour	150,000	Baghouse	5,000
Borax drying and classifying	10,000 pounds per hour	1,000,000	Baghouse and scrubber	10,000
Bulk gasoline loading rack	667,000 gallons per day	88,000	Vapor control system	50,000
Carbon black plant	2,000 gallons per day	5,000	Baghouse	5,000
Catalytic reforming unit	2,400 barrels per day	265,000	Flare and sour water oxidizer	6,000
Ceramic tile production	8,000 pounds per hour	200,000	Scrubber	10,000
Chip dryer, aluminum	2,500 pounds per hour	3,000	Afterburner	3,000
Chrome plating	4 by 5 by 5 feet	2,000	Scrubber	800
Coffee roaster	3 tons per hour	35,000	Cyclone and afterburner	8,000
Concrete batching plant	900,000 pounds per hour	125,000	Baghouse	10,000
Core oven	8 by 8 by 12 feet	4,000	Afterburner	1,500
Crucible furnace, yellow brass	4 furnaces, at 850 pounds each/heat	[1] 2,500	Baghouse	17,000
Crude oil distillation unit	37,000 barrels per hour	3,060,000	Vapor control system	10,000
Cupola, gray iron	48-inch ID	40,000	Baghouse and quench tank	67,000
	27-inch ID	25,000	do	32,000
Debonder	500 brake shoes per hour	1,800	Afterburner	300
Deep fat fryer, food	1,000 pounds per hour	15,000	do	1,500
Delayed coker unit	9,300 barrels per day	4,000,000	Scrubber (serving 3 cokers)	385,000
Drum reclamation incinerator	60 barrels per hour	10,000	Afterburner	2,000
	200 barrels per hour	25,000	do	5,000
Electric arc furnace, steel	18 tons/heat	75,000	Baghouse	45,000
Electric induction furnace, brass	2,000 pounds per hour	75,000	do	2,700
Enamel frit drying	1,500 pounds per hour	25,000	do	3,000
Fiberboard production	32,000 pounds per hour	10,000	Electric precipitator	15,000
Fire retardant manufacturing	1,000 pounds per hour	25,000	Baghouse	2,000
Fish meal system	8 to 20 tons per hour	100,000	Scrubber	50,000
Fixed roof storage tank for gasoline	80,000 barrels	50,000	New floating roof tank	132,000
Flue-fed incinerator	Most sizes	4,000–7,000	Afterburner	2,500
Fluid catalytic cracking unit	40,000 barrels per day	7,460,000	Electric precipitator	1,040,000
			CO boiler	1,770,000
			Cyclones	165,000
			Blowdown systems, vapor manifold, and flare	363,000
Do	7,400 barrels per day	1,747,500	Electric precipitator, vapor manifold, and flare	131,000
Galvanizing kettle	4 by 30 by 4 feet	25,000	Baghouse	3,000
Grit blasting machine	6 cubic feet	9,300	do	1,700
Insecticide manufacturing	1,000 pounds per hour	10,000	do	3,000
Insulation production, including cupola, blow chamber, and curing oven.	5,000 pounds per hour	13,000	Baghouse, scrubber, and afterburner	30,000
Liquid hydrogen manufacturing	32 tons per day	8,392,000	Flare	17,700
Lithographing oven	240 feet per minute	78,000	Afterburner	15,000

TABLE IV.—*Typical costs of basic and control equipment installed in Los Angeles County*—Continued

Source	Size of equipment	Cost of basic equipment	Type of control equipment	Cost of control equipment
Multiple-chamber incinerator, industrial and commercial.	50 pounds per hour	$800		
	500 pounds per hour	6,500		
	6,000 pounds per hour	75,000		
Multiple-chamber incinerator, pathological	50 pounds per hour	1,000		
	200 pounds per hour	4,500		
Multiple-chamber incinerator, wire reclamation	100 pounds per hour	1,200		
	1,000 pounds per hour	15,000		
Multiple-chamber incinerator, with continuous feed bin.	250 pounds per hour	5,000		
	3,000 pounds per hour	45,000		
Natural gas plant	20,000,000 cubic feet per day	220,000	Vapor manifold and flare	$5,000
Oil-water separator	300,000 barrels per day	170,000	Floating roof	80,000
	350 barrels per day	17,000	Cover	700
	3,500 barrels per day	32,000	Floating roof	8,000
Open hearth furnace, steel	60 tons/heat	200,000	Electric precipitator	150,000
Phosphate fertilizer production	2,000 pounds per hour	10,000	Baghouse	5,000
Phthalic anhydride manufacturing plant	25,000,000 pounds per year	1,200,000	Afterburner and baghouse	195,000
Pipe coating, including spinning, wrapping, and dipping.	4 to 10 lengths per hour	23,500	Scrubbers	32,000
Pneumatic conveyors (minerals)	200 to 5,000 pounds per hour	2,000	Cyclone and baghouse	2,000
Pot furnace, type metal	16,000 pounds	9,000	Afterburner	3,000
Rendered grease processing	6 tons per day	10,000	Contact condenser and afterburner	2,500
Rendering cooker and drier (batch)	4 tons per batch	10,000	Surface condenser and afterburner	15,000
Rendering cooker system (continuous)	15 tons per hour	100,000	do	25,000
Rock crushing and sizing	300,000 pounds per hour	75,000	Scrubber	2,000
Rotogravure press	5-color, 44-inch web	340,000	Activated carbon filter	40,000
Rubber Banbury mixer	1,000 pounds per hour	25,000	Baghouse	3,000
Sandblast room	8 by 12 by 8 feet	1,600	do	3,000
Sewage treatment digestion	9.0,000 gallons per day	800,000	Water seals and flares	7,000
Sewage treatment headworks	250,000,000 gallons per day	550,000	Covers	20,000
Sewage water reclamation	17,000,000 gallons per day	1,500,000	Covers and aeration tanks	25,000
Sewer pipe manufacturing	20,000 pounds per hour	1,000,000	Baghouse	10,000
Ship bulk loading	2,500 tons per hour	500,000	do	168,000
Smoke generator and smokehouse	11 by 14 by 11 feet	18,000	Precipitator, scrubber, and afterburner	42,000
Sulfuric acid plant	250 tons per day	1,900,000	Electrostatic precipitator	150,000
Sulfur recovery plant	2 parallel units, 65 tons per day, each	1,400,000	Incinerator	30,000
	10 tons per day	265,000	do	5,000
	2,840 pounds per day	30,000	do	1,000
	8,000 pounds per day	60,000	do	1,000
Sweat furnace, aluminum	3,000 pounds per hour	3,500	Afterburner and baghouse	3,500
Synthetic rubber manufacturing	30,000 tons per year	1,600,000	Vapor manifold and flare	250,000
Synthetic solvent drycleaner	60 pounds per batch	14,000	Activated carbon filter	3,000
Varnish cookers (2)	250 gallons each	4,000	Afterburner	5,500
Wallboard production	60,000 pounds per hour	1,500,000	Baghouse	100,000

[1] Cost per unit.

PROBLEMS FOR FURTHER CONTROL

The three air pollution problems in Los Angeles County which are still of major concern and which must be further controlled are fuel oil burning, organic solvents and the motor vehicle.

1. Motor vehicles

The complete solution to the smog problem in the Los Angeles Basin depends not only on control of stationary sources, but also upon the control of emissions from motor vehicles. As stationary sources have been controlled, and vehicle population has risen, pollution from vehicles has increased in relative importance until it is now responsible for about 85 per cent of the contamination in the atmosphere in the Los Angeles Basin.

To indicate the magnitude of the problem, in the beginning of 1965, 3.5 million motor vehicles in Los Angeles County were consuming a daily total of 7.4 million gallons of gasoline, resulting in emissions to the atmosphere of 12,800 tons of air contaminants. This figure is indeed startling when it is realized that only 5900 tons of contaminants were emitted from vehicles in Los Angeles County in 1948. (See Table V.)

The most conspicuous effects of smog, eye irritation, reduced visibility, and damage to growing vegetation and to property, are traceable to the "photochemical smog reaction". This occurs when auto exhaust is acted upon by sunlight. The hydrocarbons, which are present in the exhaust as unburned gasoline, react chemically with oxides of nitrogen, which are formed during the burning process in the engine. The resulting chemical products create smog.

While the exhaust is responsible for the largest emission from motor vehicles, crankcase and evaporation emissions must also be considered. Crankcases must be ventilated if the engine is to continue to operate properly, but the fumes vented contain substantial amounts of unburned gasoline that leak past the piston rings. This leakage, termed "blowby" accounts for about 25 per cent of the total hydrocarbon emission from automobiles. For this type of emission there is a simple system of control which involves recirculating the crankcase emissions back into the engine intake system so they are drawn into the cylinders and burned.

TABLE V.—*Emissions of air contaminants into Los Angeles County atmosphere from motor vehicles*

Source	Average daily emissions of air contaminants (in tons per day)									
	Hydrocarbons and other organic gases		Oxides of nitrogen		Oxides of sulfur		Carbon monoxide		Aerosols	
	1948 [1]	1965	1948	1965	1948	1965	1948	1965	1948	1965
Gasoline-powered vehicles:										
Exhaust	630	1,400	215	490	47	30	4,570	10,300	20	45
Blowby [2]	215	190	------	------	------	------	35	30	------	------
Evaporation	155	340	------	------	------	------	------	------	------	------
Diesel-powered vehicles	6	8	6	8	1	2	2	2	2	2
Total (rounded)	1,000	1,940	220	500	50	30	5,000	10,330	20	45

[1] 1948 emission data has been revised on basis of 1965 baseline data.
[2] Blowby emissions are not controlled in 1948 and are partially controlled in 1965.

As a result of laws passed by the California State Legislature in 1959 and 1960, the State of California occupied the field for control of the motor vehicle. Under these laws, the Motor Vehicle Pollution Control Board was given jurisdiction over vehicular emissions in the testing and certifying of vehicle control devices, while the Department of Public Health was given jurisdiction over health aspects, in the establishing of standards for air quality and motor vehicle exhausts. More recent federal statues shift the responsibility for new car control to the federal government, leaving only used car control in the hands of the state government.

Nevertheless, the 13-man California Motor Vehicle Pollution Control Board was the first to establish criteria for both crankcase and exhaust control devices.

Crankcase emission control systems have been installed on most new cars sold in California since 1961 and most used cars are required to be equipped with "blowby" control devices when sold. American automobile makers have been equipping all models manufactured in the United States since 1963 with California-approved crankcase control systems.

At the same time, great progress has been made by the automobile manufacturers in their attempts to reduce exhaust emissions. California motorists now have new cars delivered to them with factory-equipped devices or engine modifications permitting the exhaust emissions to conform with the California State Standards for Clean Air. This solves part of the problem, and it is anticipated that the remaining part, control of exhaust emissions from used cars, will be controlled by some of the devices developed, catalytic and direct-flame afterburners.

But neither this, nor any other solution to the motor vehicle problem, or any other air pollution problem, could have been envisioned, much less developed, if the public had not demanded action and the control agency and the government officials had not accepted their responsibilities and worked to find the solutions.

2. Fuel oil burning

The boilers now operating in steam power plants in Los Angeles County discharge visible smoke emissions when fired with heavy residual fuel oil and emit substantial quantities of sulfur oxides, particulate matter and oxides of nitrogen.

The Joint Research Council on Power Plant Air Pollution Control was formed in 1956 for the express purpose of eliminating air contaminants from power plant flue gases. Since then, a great deal of money has been spent by participating power plant operators, both on the study of plume formation and on means of removing pollutants.

Some important research by the Southern California Edison Company to control the particulate matter emissions from power plants indicated the possibility of using an electrical precipitator. A one million dollar electrical precipitator was built but did not prove up to expectations. Subsequently, a one and one-half million dollar glass filter cloth baghouse was constructed to serve a new unit during oil-firing and is still being investigated. To increase effectiveness in removing particulates from the flue gases, powdered dolomite is injected into the gas stream as a filter aid prior to entry to the baghouse.

Strong efforts have also been made to secure additional natural gas supplies so that fuel oil burning can either be eliminated or restricted to periods when weather conditions are not conducive to smog formation. The substitution of natural gas eliminates six-sevenths of the pollution from power plants. During the peak periods of fuel usage, if all gas were burned the emissions would be reduced from 1,285 tons per day to 290 tons per day—eliminating 995 tons per day. The reductions of specific contaminants are: sulfur dioxide, 735 tons per day; oxides of nitrogen, 185 tons per day; aerosols, 65 tons per day; and hydrocarbons, 10 tons per day.

3. Organic solvents

In the industrial, commercial and domestic activities carried on in Los Angeles County many different solvents are used which are eventually vaporized into the atmosphere. Alcohols, ethers, paint thinners and lacquer thinners, are included in the definition of organic solvents. These organic solvent vapors react in the Los Angeles atmosphere to produce smog in the same manner as gasoline vapors.

Surveys have been made to identify sources of emissions and usages of solvents; research experiments have been performed to determine the reactivities of various solvents; and engineering projects have been completed to develop feasible controls. The most recent estimates indicate that about 550 tons per day of these solvents are discharged into the atmosphere.

Engineering studies indicate three approaches to the successful reduction of organic solvent vapor emissions: (1) installation of equipment to capture, or consume, the organic vapors; (2) introduction of an operational change; and (3) alteration of the type of solvent used, probably the substitution of less reactive organic solvents or inorganic solvents such as water.

Many direct flame incinerators are used in Los Angeles County today for control of odors and other combustible gases, including solvent vapors. These vary in size; some can incinerate 700 pounds of solvent daily, others only a few pounds. One plant alone has 14 units which incinerate a total of 4,800 pounds

of solvent each day. Laboratory analyses have provided data needed on the efficiency of units in incinerating solvents evaporated during the baking of various organic surface coatings to guide the Air Pollution Control District engineers in their evaluations of permit applications.

The adoption of Rule 66 will be the District's major action to eliminate or reduce the effect of solvent emissions. Cognizance by industry of the District's intent with regard to solvents has led to several technological advances which are Engineering "firsts" in air pollution control. One such "first" is the integral bake oven-afterburner combination wherein the direct-fired afterburner supplies all the heat required by the oven. The first such unit was placed in operation August 1964. There are now many units in operation in Los Angeles County that are partially heated by the afterburner control.

CONCLUSIONS

From our experiences over the years we can draw two important conclusions. First, the technical know-how and the actual control devices are now available for the control of almost any air pollution problem existing from stationary sources and soon will be available for the control of vehicular sources. Second, each community must determine for itself the degree of clean air it desires and the price that the community is willing to pay for that degree of clean air.

In Los Angeles, the price has been high because the control program was a pioneering effort. The price in other areas should be much lower because of that effort. Results, answers and techniques now are available that can be of benefit to other areas. Our experiences need not be repeated in every urbanized area facing an air pollution problem. The mistakes, as well as accomplishments, should prove valuable guidelines for other areas to follow. The price any community pays, therefore, for a comparable reduction in air pollution should be far less than it has been in for Los Angeles.

Mr. FULLER. The ink is hardly dry on this report, but I would like to invite your attention to page 15 of that report, gentlemen. Now, when I tell you that millions of dollars have been spent locally, and that the burden of the expenditure has been borne by the local taxpayers, this is what I mean to indicate. That as a result of the work we have accomplished over the past 18 years, in conjunction with industry, and I would like to stress that, we have achieved a degree of control of stationary sources which I believe is second to none anywhere in this world.

Now that this research has been accomplished, the results of the research are very apparent. The types of industry which are being controlled is clearly set forth and delineated here.

If I might, I will ask you to move forward in the report to page 25. There is a list of sources of air pollution from industrial operations, the size of equipment, the cost of the basic equipment, and type of control equipment and the cost. I am sure this may be of interest to the Library of Congress because I think it belongs there.

I believe further, gentlemen, that all of this work which has been done has shown conclusively that the vast majority of industrial operations which produce air pollution can be controlled. There is no question about this.

I think it would be a waste of public funds to duplicate this. I would suggest to the committee for their consideration that all of the research and data which has been accomplished by this district over the past 18 years be made available to every other urban area with a population in excess of 50,000.

We have produced some guidelines in the way of manuals which are the Bible now for other air pollution agencies. The Public Health is now printing our Engineering Manual of which there has been a

crying need of agencies just waiting for it. When the proofs of our manual were forwarded to Cincinnati I received a call. They said, "May we start using this now? We don't want to even wait for the publication."

I think this manual alone cost us over $100,000 to produce.

Now, if we have this information, gentlemen, and we do have it, I think it would be a great contribution to the reduction of air pollution in other urban areas throughout the United States if this could be made available piece by piece. If you want to know how to control an asphalt saturator, we know how to control it.

Last week I received a telephone call from Toronto, Canada on how to control asphalt saturators. We send out this information.

It is a cost factor. We receive visits from all over the world, including the Soviet Union, incidentally. We have given freely of all of the information which we have, but it is a cost factor.

Now, lest you get the impression I am asking for dollars, I am not. All I ask is that if this information which is so vitally needed by other areas could be made available at no cost to the district (and no profit), we would be most willing to cooperate with the Federal agencies to have them send a staff of people into this area for the purpose of reproducing all this information.

In my basket this morning I received a letter which is typical, and I will read just one portion of it, if I may.

> There is one item of unfinished business, however, which we must not neglect, and that is to thank people like yourself who gave so much assistance in our long fight. Your very helpful advice, the information obtained from you and the help so freely given by yourself were all of tremendous assistance, and for that we are most grateful.

We do this daily, and we like to do it, but it is certainly a cost to the taxpayers of Los Angeles County. We don't have the personnel who can sit down and write this information in terms which could be of extreme value to local air pollution agencies that do not have an engineering staff.

Anything they have of a local nature, an industrial source which lends itself to the type of control listed here page after page, you can see that it is available.

In some of these areas I think you will find the cost of the control equipment exceeds the cost of the base equipment. In some instances, industry has come to us and said voluntarily, "We think we can control this emission from our operations, and we would like to build this type control equipment."

Our engineers would sit down with them and make a determination, and the cost to industry itself has been on occasion, for a single control device, in excess of a million dollars.

Now, this, to me, represents an attitude on the part of industry which must not be rejected. I think industry generally throughout this country has an expertise and the knowledge and skills which must be brought to bear on this problem.

This is not a problem which can be controlled simply by the creation of a public agency and a few tax dollars. Industry must be brought into full partnership, if we are to whip this problem.

So in conclusion I would only wish to read the last paragraph.

From our experiences over the years we can draw two important conclusions. First, the technical know-how and the actual control devices are now available for the control of almost any air pollution problem existing from stationary sources. Second, each community must determine for itself the degree of clean air it desires and the price that the community is willing to pay for that degree of clean air.

In Los Angeles the price has been high because the control program was the pioneering effort. The price in other areas should be much lower. The results and answers and techniques now are available that can be of benefit to these other areas. The experiences in Los Angeles need not be repeated in every urbanized area facing an air pollution problem. There are valuable guidelines for other areas to follow, and the price which any community pays for clean air, therefore, should be far less than here locally.

Thank you, gentlemen.

Mr. BROWN. Thank you, Mr. Fuller. Your statement and your report will be of tremendous value to the committee. Your offer of sharing the know-how of Los Angeles County I am sure should be taken advantage of, as many agencies have already taken advantage of it, and if we can be instrumental in helping to further this, I am sure Mr. Bell and I have enough pride in Los Angeles that we will do our best to do that.

Mr. FULLER. I am sure you will.

Mr. BROWN. I wanted to ask a couple of questions.

With regard to the devices which have been developed for controlling the various manifold number of stationary sources of emission around here, is there a problem with regard to proprietary or patent rights that may have been generated on these devices as they are developed, particularly by local industry? Would there be that sort of problem in sharing that know-how, or do you feel this is not significant?

Mr. FULLER. No, I don't think that is a problem, because the device, whether they be precipitators, afterburners, or what ever, are in production by private industries. We do not have a proprietary right to a specific device. When devices have been developed in conjunction with engineers from industry, we finally arrived at solutions to specific problems, and these devices have met the test of our rules and regulations, and they are effective.

I don't think there would be any problem involved there.

Mr. BROWN. I noticed in glancing rapidly through the list of devices and instruments and so forth that there are some which have the effect of cleaning the air, or washing it clean, but in effect translating the pollutant into another medium.

Mr. FULLER. Yes.

Mr. BROWN. Has this problem of translating an air pollutant or air contaminant to a ground contaminant raised any problems as yet in this area?

Mr. FULLER. No. As a matter of fact, there are some industries which are showing a profit as a result of the control device which they are operating.

This is true in evaporation losses from refineries. This is true in the contaminants generated by the making of steel.

One of the local industrial operations—I try to keep away from names—has found that the contaminant which has been recovered was running a very high percentage of nickel.

This was reduced and pelletized and shipped to Utah for smeltering, and they have recovered the cost of their control equipment.

Mr. BROWN. I wish that could be true of all industry,

Mr. FULLER. I do, too.

Mr. BROWN. Congressman Bell?

Mr. BELL. Just a few questions.

It is a pleasure to welcome you here before the committee, and I am certain, as Chairman Brown has indicated, we can take great pride in sending to other areas suggestions you have made.

How can the training and equipping of local agency officials be coordinated with industrial pollution control personnel?

Mr. FULLER. I am sure you gentlemen are aware of the fact there is presently in effect grants for the training of air pollution officials in the universities, one particularly in the University of California.

I think this effort is in swaddling clothes at the present time. I thing there has to be a review of the training programs to bring a more practical aspect to it. I think it is time for the coveralls to be put on, and to actually enter industry and get acquainted with the problem in that area under the heat and stress of production, rather than in the classroom with the blackboard.

I think that the program can be advanced. As to how this can be accomplished, again the local agencies, including this agency, have reached the extent of our fiscal responsibility here, and I don't think we can go any further.

I have heard rumors there is a city back East that has unlimited funds they dole out by the basketful. I don't necessarily believe that, but I think that the Federal Government has a responsibility to proceed as far as is absolutely necessary, but no further.

In those areas where the local district is completely handicapped either by technical knowledge or financial support, then the Federal Government does have the responsibility for the health of its people.

Mr. BELL. Would you say in the Los Angeles area the Federal Government has some responsibility?

Mr. FULLER. Yes, I do, for this reason. I don't want to paint too rosy a picture here, I don't want you to leave here under the impression everything has been solved here. It hasn't. There are still some problems that are very knotty problems, and will require the finest type of research.

For example, the control of nitrogen oxides. Oxides of nitrogen are a very serious problem because they, as you know, are highly toxic, and last longer than carbon monoxide.

So there are still some areas where we don't have the ability in Los Angeles. We have a modest laboratory here, but we no longer have the support and money to proceed with that type of research, but it must be done.

Mr. BELL. So you feel there should be some additional effort on the part of perhaps a partnership arrangement between State, local and Federal and industry generally to further research and study in this area?

Mr. FULLER. Yes. This is a tough one, but certainly industry will play an important part. They are certainly willing to do so, in my opinion, and I think that the financial support necessary for this must be obtained.

Mr. BELL. One more question, Mr. Fuller.

To what extent should zoning of selected industrial locations in respect to population be used to decrease the need for effluent treatment?

In other words, the moving of industries, and so on. How far should we go in this area?

Mr. FULLER. I think this is a problem that I think is facing everybody. Even as the mayor of Monterey Park, you had a zoning problem. Where a small community must rely upon industry for fiscal responsibility, there is a tendency to say, "Well, it shouldn't be there, but we need it and we invited you, so go ahead, and we will zone this area for manufacturing and whatever is necessary."

Of course this is a most important aspect of air pollution control.

We here in the district have a meteorological section in which we deal in micrometeorology which the Federal Government has said they don't have the degree of exactness that we have here. Because we have been at it a number of years here, we can predict where pollution will occur in a certain portion of the basin, which we did last Friday.

We said there was a strong possibility of a smog alert downtown, which we almost got to. We got to a reading of 46, and 50 would have caused an alert.

We cooperate with zoning commissions and boards throughout the county. We are available on call for testimony to produce meteorological information to help on any zoning.

This is certainly a very necessary part of expanding whenever you are faced with a situation like we are now, where I don't think moving a factory 1 or 2 miles in either direction is materially going to affect an area such as this Los Angeles Basin.

Mr. BELL. Mr. Fuller, I would like to commend you for a very fine statement.

Mr. FULLER. Thank you.

Mr. BROWN. Just a concluding word, Mr. Fuller. This job for you is a second career.

Mr. FULLER. Yes. I am about to enter into a third one. I got a call from Washington this morning. The Secretary of HEW asked me if I would accept the chairmanship of hearings between Maryland and Delaware. So I may be a professional consultant on abatement.

Mr. BROWN. You have certainly shown the ability to master this field, and it indicates at least some people can solve this problem of retraining that Dr. Haagen-Smit spoke about.

Thank you for being here this morning.

(The prepared statement of Mr. Louis J. Fuller follows:)

PREPARED STATEMENT OF LOUIS J. FULLER, AIR POLLUTION CONTROL OFFICER, LOS ANGELES COUNTY AIR POLLUTION CONTROL DISTRICT

My name is Louis J. Fuller. I am the Air Pollution Control Officer of Los Angeles County. It is a pleasure to appear here today to provide any information that I can, which may be helpful to your Honorable Committee.

Let me begin by describing the statuts of air pollution control in Los Angeles County.

As you gentlemen are aware, air pollution first became a noticeable problem in Los Angeles during World War II. Today, more than twenty years later, it still remains; however, it is not the same problem, any more than this is the same Los Angeles.

The air pollution experienced during the late forties and early fifties consisted of about 40% emissions from stationary sources—industry and rubbish disposal—and about 60% of emissions from automobiles. Today, pollution from rubbish disposal has been eliminated, pollution from industry has been reduced almost to the practicable minimum, but pollution from motor vehicles has been controlled only slightly. In the meantime, the number of motor vehicles has more than doubled, and there is more than twice as much pollution from this source as there was when the control program began. The ratio now is approximately 10% from stationary sources and 90% from motor vehicles.

At present, control measures now in effect are keeping a total of 6185 tons of pollution out of the air of Los Angeles County every day. Of these 6185 tons, 5085 tons are controlled as the result of the steps taken by the Air Pollution Control District in regulating stationary sources. The other 1100 tons are being controlled by the installation of crankcase and exhaust control devices.

Still uncontrolled and being emitted are pollutants totaling 13,730 tons per day. Of this, 1310 tons come from all stationary sources including not only industry, but all combustion processes such as domestic heating and cooking as well. The other 12,420 tons are being emitted from motor vehicles, meaning for the most part from the exhaust pipes of gasoline-powered automobiles.

That is the balance sheet: 6185 tons controlled; 13,730 tons uncontrolled. That which can be controlled from non-moving sources has been almost completely controlled; that which can be controlled from automotive sources has scarcely been touched and makes up 90% of our problem.

The cost to control 5085 tons of pollution from stationary sources has been at least three-quarters of a billion dollars. Some of this we can measure with exactness, the remainder we can estimate. For example, a permit must be obtained for every piece of air pollution control equipment installed in Los Angeles County, and we keep a precise record of the cost of this equipment. Our records show that industry has expended more than $130,000,000 for such control equipment. This does not include, however, the cost of maintaining or operating this equipment, or the value of the land it occupies, nor does it take into account the cost of designing and building into other basic equipment the modifications necessary to meet our requirements without use of separate control devices. Wherever this is possible, it is done. The true cost to industry may be twice the $130,000,000. Another item which we measure precisely is the amount paid for fees for these permits, and the amount paid as fines for convictions of violations of our Rules. Since 1948 these two items amount to $2,875,000. We also know accurately the cost of the Air Pollution Control District for the eighteen years of its existence: $42,530,300. Of this amount, more than $6 million have been spent for basic research. In addition, however, Los Angeles County taxpayers have also borne a pro-rata share of the air pollution expenditures of the State of California and of the Federal Government; and that is a sizable amount.

Another area of expense has been rubbish collection and disposal, which costs an estimated $55,000,000 a year in Los Angeles County. Since 1957 this has amounted to about $450,000,000.

All of this expenditure for control is only the top of the iceberg of the cost of air pollution. There is no way of knowing the full cost to Los Angeles County over the past twenty years, but we can make an estimate. President Johnson has given the Federal Government's estimate of the cost of air pollution to the nation as eleven billion dollars each year. Los Angeles County represents about five per cent of the national market, and if we assume that we share the national air pollution cost in the same five per cent proportion, then in twenty years we have suffered a loss equal to eleven billion dollars. Because the figure is so staggering, our inclination is to discount it, and then discount it again, but even so we must conclude that the loss has been tremendous. And that is without taking account of the loss of productivity due to the distress of air pollution, and the price of pain and suffering, impaired health and loss of well-being for millions of people. Nor does it take into account the general friction and drag on the entire mechanism of society caused by the debate, and pulling and hauling over the problem; the deluge of billions of words printed and spoken about the subject; the legislative hours expended, and the cost in time and money of pro-

ceedings such as this very hearing. For example, the cost to the APCD of just two proceedings that have extended over the past three years—the hearings before the Federal Power Commission on applications to bring more natural gas here, and the case in the Superior Court brought by the Western Oil and Gas Association—have cost the County of Los Angeles at least $250,000, and the end is not in sight for either of those matters, which will exhaust all possible avenues of appeal before they terminate.

It is against this backdrop of cost and loss—the three-quarters of a billion in costs of control, the eleven billion in loss due to air pollution—that we must evaluate the steps necessary to stop this bleeding.

Now I would like to tell you something about the Air Pollution Control District, and what we are doing to control air pollution here in Los Angeles County.

The Los Angeles County Air Pollution Control District has 305 personnel, and our budget for 1966–67 is $3,565,000. Our District is organized into 6 divisions: Engineering, Enforcement, Technical Services, Evaluation & Planning, Public Information & Education, and Business Management.

You will forgive me if I say with some pride that the Los Angeles County Air Pollution Control District is recognized internationally as the leading agency of its kind. Its function and structure are a model for the guidance of other agencies. The U.S. Public Health Service has printed as the standard guidebook "The Air Pollution Control Field Operations Manual," which describes our practices and procedures. They are now printing our Engineering Manual which sets forth the design criteria of both basic and control equipment. They are the "How-to-do-it" for air pollution control officials everywhere. The Vice-President of the United States recently said, "The war Los Angeles is waging against air pollution is already a modern legend . . . The experience of Los Angeles has shown that local governments can control most sources of air pollution, if they will . . . The skeptics would do well to take a close look at what you have achieved here.

The prohibitions contained in the Rules and Regulations of the Los Angeles County Air Pollution Control District govern smoke, nuisance, particulate matter, sulfur compounds, combustion contaminants, dusts and fumes, open fires, incinerator burning, storage of petroleum products, oil effluent-water separators, gasoline loading, sulfur content of fuels, gasoline composition, solvents, and animal reduction processes.

It can be seen from this impressive list that the Rules and Regulations affect the operation of every industry; almost every commercial endeavor; and, in at least one direct aspect, every homeowner in Los Angeles County. Through their enforcement, controls have been applied to such diverse sources and operations as incinerators, rendering cookers, coffee roasters, petroleum refineries, chemical plants, rock crushers, asphalt plants, open hearth furnaces, electric furnaces, automobile assembly plants, as well as less obvious sources such as restaurants, crematories, and housing tract developers. From the smelting of metal to the production of dog food, air pollution-prone operations have been brought within the scope of the control program.

The types of control devices installed vary widely in cost and collection efficiency. Among these are electric precipitators, baghouses, afterburners, separators, scrubbers, absorbers, adsorbers, and various types of vapor collection equipment. Each type of device possesses advantages and limitations that must be considered carefully. Each source poses different problems in terms of volume, temperature, and characteristics of the waste emitted from it. The degree of control which a community requires will dictate, in the main, which type control device will be utilized and, hence, the cost of the control system.

From our experiences over the years we can draw two important conclusions. First, the technical know-how and the actual control devices are now available for the control of almost any air pollution problem existing from stationary sources. Second, each community must determine for itself the degree of clean air it desires and the price that the community is willing to pay for that degree of clean air.

In Los Angeles, the price has been high because the control program was a pioneering effort. The price in other areas should be much lower because of that effort. Results, answers and techniques now are available that can be of benefit to other areas. The experiences in Los Angeles need not be repeated in every urbanized area facing an air pollution problem. The mistakes and accomplishments in Los Angeles should prove valuable guidelines for other areas to follow. The price any community pays, therefore, for clean air should be far less than it has been for Los Angeles.

Mr. BROWN. Our next witness is Mr. Eric Grant, executive officer of the California State Motor Vehicle Pollution Control Board.

We are glad to have you here, Mr. Grant. I think it is obvious to everyone here, and to the committee, I am sure, but Mr. Fuller and Mr. Grant have complementary responsibilities in the smog field. Basically, the emphasis on the part of Mr. Fuller was with the control of stationary sources in Los Angeles County.

Mr. Grant's responsibilities deal with the problems of moving sources, the automobile, the truck, and anything else related to motor vehicles.

We are very happy to have you here to hear your testimony, Mr. Grant.

STATEMENT OF ERIC GRANT, EXECUTIVE OFFICER, CALIFORNIA STATE MOTOR VEHICLE POLLUTION CONTROL BOARD

Mr. GRANT. Thank you, Mr. Chairman.

I would like to indicate that Mr. Fuller and I have many relationships in common. It was my luck almost 11 years ago while going to law school to be hired by Mr. Fuller to go to work for Los Angeles County Pollution Control District. So he is keeping an eye on me.

I have a prepared statement, Mr. Chairman, and also some information that I would like to submit for the record, so you can review it at your pleasure and leisure.

Mr. BELL. I move that be a part of the record.

Mr. BROWN. Without objection, they will be made part of the record.

(The prepared statement of Mr. Eric Grant and the information referred to follows:)

PREPARED STATEMENT OF MR. ERIC GRANT, EXECUTIVE OFFICER, CALIFORNIA STATE MOTOR VEHICLE POLLUTION CONTROL BOARD

Mr. Chairman and Members of the House Committee, it has always been the policy of the Motor Vehicle Pollution Control Board to keep you well informed as to the activities and progress which we have been able to accomplish toward control of emissions from motor vehicles.

It is my pleasure to indicate to you today that our accomplishments have been significant; that our control programs are eliminating large amounts of raw gasoline from the atmosphere; and that the future results from our continued efforts we feel confident, will ultimately eliminate the motor vehicle as a source of pollution.

This chart (p. 560) shows, we have made great progress, but there is still a long way to go. We know that each day less pollutants are going into the atmosphere. In Section 1 of the pamphlet submitted for the record, the information contained therein indicates that the control systems on 1966 model vehicles are working effectively, and the 1967 model vehicles will be equipped with even better systems. The efforts of the Motor Vehicle Pollution Control Board, as a result of the strong support received from this Committee, the Governor's Office, and the Senate Transportation Committee, have allowed us to cooperatively demand from the American automobile industry controls that actually do function effectively and conserve our natural resource, air.

We know that our efforts have caused the manufacturers of motor vehicles to not only install control equipment, but to be more concerned about quality control in their production. They have up-graded the quality of carburetors, ignition systems, and many other components of the engines. We also know that throughout the State of California, pre-delivery service performed by dealers prior to delivery of the vehicle to the purchaser has greatly improved. The ultimate result is that the motorist in California is purchasing a better vehicle.

We know that our efforts to date with over six million vehicles equipped with crankcase control devices, and with approximately 800,000 1966 model vehicles equipped with exhaust control equipment, keep from our skies nearly 400,000 gallons of gasoline each day. A unique factor involved in this is that a large percentage of this gasoline is being used by the motorist at a considerable saving to him. As an example, we know that a properly installed crankcase emission control system results in about a 3% increase in mileage, since raw gasoline which was going out into the air is now kept in the engine and used as fuel.

There is also a report made to the Board by Mr. John Maga, of the State Department of Public Health, Bureau of Air Sanitation, which indicates in Figure 1 that the results of our efforts to date have caused about a 30% reduction in emissions into the atmosphere of contaminants which would have been present if we had not taken action commencing in 1960.

In Section 3 of the information is a report on the crankcase control program. Of particular importance are the statistics on Page 4 which indicate that there are still about 1,250,000 vehicles which still need to be equipped, and presumably a sizable percentage of these will be subject to our regulations because of sale and transfer of ownership in the future.

We have also made a real effort to control emissions from diesel vehicles. The obnoxious black smoke which, under some conditions is emitted from diesel vehicles, has been reduced on the highways of California due to legislation passed at the last Session, and the cooperative efforts made by ourselves and the California Trucking Association, which organization has made a diligent effort to secure cooperative interest on the part of its own members to achieve control of their diesel vehicles.

We now have standards for odor and visible smoke, and possibly in the future devices will be developed that may be applied to diesel vehicles. In the meantime, however, due to the complexities of the control of these emissions, we feel that strong on-the-road enforcement, plus cooperative interest, have and will achieve a great deal.

There has been considerable interest shown in the control of oxides of nitrogen. In Section 5 of the submitted material, we have Title 13 of the California Administrative Code. On Page 5 are the criteria which have now been finalized. We are prepared to evaluate any device to control oxides of nitrogen. None as yet has been presented to the Board.

In Section 6 of the pamphlet, you have for your files a copy of all the laws relating to motor vehicle emission control in the Health and Safety Code. This includes those sections from Assembly Bills 72, 73, 74, 75 and 98, passed at the last Session.

I hope, Mr. Chairman, that this has defined the present status of the Board. I would like to indicate additional areas of concern. The Board, at its last meeting, took a strong position in support of the need for continued increased effort to secure more and better control of emissions from motor vehicles. As the charts indicate, we cannot achieve 1940 air unless this action is taken. The automobile industry and the Federal Government have been made aware of the absolute necessity of accomplishing the 1970 standards recommended by the State Department of Public Health.

We strongly support the need for a state-wide concept of conservation of our air resource, which necessitates the creation of a state-wide agency which will function as a coordinating, and if necessary enforcing agency, to control emissions from all sources. We are convinced that the people of California, the Legislature, and the Administration no longer can permit indiscriminate, uncontrolled, illegal contamination of the air we breathe.

Present standards established by the State Department of Public Health are only recommended for 1970 under present law. They would not become mandatory until two or more devices have been developed to meet the requirements. I feel that as the charts indicate, it is essential that we make these 1970 standards mandatory and give notice to industry that their vehicles shall not exceed these basic requirements. I feel that it is within the ability of the industry to control their vehicles to this degree, and that certainly a timely notice to them would give them sufficient time to comply and deliver to the California motorists vehicles that do not emit excessive pollutants into our atmosphere.

We in California cannot take a chance that the Federal Government will answer our needs. We recognize that your Federal efforts will result in a strong vehicle emission control program nationwide. However, at the same time we know that our control efforts here must continue at the strong leadership level we have established.

All present controls on stationary sources in America are patterned after the Los Angeles County Air Pollution Control Districts' program.

All present controls on vehicles in the world are patterned after our State Motor Vehicle Pollution Control Board's actions and leadership.

You and your colleagues in Washington must recognize the importance of this and not allow Federal entry into this area to diminish its effectiveness. Local, State and Federal efforts to collectively work together to accomplish our needs have in the past and should in the future result in significant program gains.

Gentlemen, in conclusion I would like to indicate to you again that the Board is confident that considerable pollution is being kept from the air, and that this is an important factor in the fact that there have been fewer incidents of air pollution; and that with each day that passes, there will be more and more vehicles on the road which are controlled. I would like to emphasize, however, that we are a long way from our goal. There is still serious air pollution, and if the weather is adverse we shall have smog alerts. We shall put forth continued effort so as to assure the people of Califronia that eventually the air of California will be fit to breathe.

MOTOR VEHICLE POLLUTION CONTROL BOARD

(Eric P. Grant, Executive Officer)

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A

STATE OF CALIFORNIA MEMORANDUM

AUGUST 10, 1966.

To: The Chairman and Members of the Board.
From: Motor Vehicle Pollution Control Board, Eric P. Grant, Executive Officer.
Subject:

The 1966 motor vehicles equipped in California with exhaust emission control devices are the result of action by your Board in approving systems submitted by the manufacturers. The conditions of approval were based upon engineering evaluations, in the State's laboratories and proving-ground data accumulated by the manufacturers, indicating that the devices would satisfactorily control emissions to the required State standards. Letters of representation from each of the manufacturers indicated that the systems would comply with the basic criteria when in service and installed on the motor vehicles sold to the motoring public.

The Board now must consider systems for the 1967 model vehicles.

Action by the Legislature and this Board eliminated compulsory annual recharging or servicing of exhaust devices, such that they must have durability equal to the car itself. As you are well aware, our test procedures require that durability and certification fleets be run by the manufacturers. The durability fleets are representative vehicles of the various engine, transmission combinations. These were run for 50,000 miles. By running the vehicles for this period of time, a trend of emissions was established for the life of the vehicle or 100,000 miles. Each manufacturer then fitted into this basic curve all the other various makes and models. The data thus accumulated from manufacturers indicate compliance with the emission standards for the life of the vehicle.

Surveillance data indicates that the average emissions are 223 PPM H.C. and 1.17% CO on a hot-start basis and 281 PPM HC and 1.62% CO on a cold-start basis. The reasons for this variance are discussed in the report. Average proving-ground data supplied for 1967 certification is 220 PPM HC and 1.23% CO. These figures represent a composite of the durability data supplied by the manufacturers for the 1967 model vehicles. You will note that the emissions are lower than those found on the 1966 models in public use. The importance of these figures are two-fold. First, that the manufacturers have achieved a significant reduction, and when considering all available data, have complied with the basic State standards as required by this Board. Secondly, these data are subject to question in that it represents a relatively small number of vehicles under various test conditions, as indicated in the attached report. There is a wide range of emissions, even between identical vehicles. Other variations in emissions are significant depending upon the type of tests, cold versus hot, conditions under which the vehicle was received, the mileage on the motor vehicle at the time of the test, and many other factors.

In considering the approval of the 1967 systems, the Board should consider surveillance data accumulated by the staff on 1966 model vehicles in use in California, and also improvements made in the basic systems.

Of great importance is the need for continued surveillance, representing more vehicles. There is considerable effort being put forth to have more and better surveillance data available. Surveillance is being carried on by your staff, and increased effort will be made to get more tests, both hot and cold. Additional tests are being run by the motor vehicle manufacturers. In addition, there is the ever present need to stabilize test methods and test conditions specified for the vehicle when it is received. It is our intent to nail down with the manufacturers an exact procedure and co-relation factor, if one can be established between hot and cold start tests. It is the feeling of the staff that by far the better method statistically would be to secure a very large number of hot start tests and corelate these to cold start officials test procedures. However, as is pointed out, there is this problem of relating cold to hot starts.

State standards

The original State standards established by the State Department of Public Health were based on average emissions of the car population (as measured in 1956) of 1375 parts per million of hydrocarbon, and an 80% reduction of these emissions was required. This resulted in a 275 part per million State standard. Based upon the data herein presented and the projection of emissions for the 1967 systems, the systems meet the requirements specified by the State Department of Public Health. Present emissions in the vehicle popula-

tion are considered to be less than the original 1375, due largely to improvements in test technique, and are established at approximately 900 parts per million. Based upon this figure, there is a 70% reduction of total exhaust hydrocarbon emissions due to the installation of these systems. The carbon monoxide standard is based upon existing emissions, and a 60% reduction of carbon monoxide was specified. Again, based upon surveillance data and submission of test emission data from the manufacturers, the 1967 systems do comply with these requirements.

The reason for this reduction in total average emission can be attributed to several factors, one of which is improvements made by manufacturers.

I feel that the efforts of this Board have resulted in a total emission reduction from all vehicles. All manufacturers now consider "emissions" as a major design criterion for engines.

Vivid evidence of this is present today when several manufacturers will present new "controlled engines" for your consideration, which have achieved State standards by considering emissions early in the engine design phase. These "controlled engines" are also less costly to the motorist than present air injection systems.

Of particular importance also is the direction influence that your honorable Board has caused upon the manufacture, assembly and pre-delivery preparation of automobiles in California.

Quality control, assembly upgrading and pre-delivery service have all been improved. The end result is a better vehicle being sold to the motorists of California.

Criteria

The Board has numerous criteria with which any system must comply, in addition to State standards. These criteria basically relate to the cost and operation of the system when installed on the motor vehicle. Surveillance data, and the letters of representation from officers of each of the corporations, gives assurance that the systems have in the past, and will in the future, continue to comply with the criteria established by this Board. This is not to indicate that there are no problems with the vehicles when in operation by the motoring public. Our surveillance data indicates there have been problems with the operation by the motoring public. However, the data does support fully that these problems have not been great in number. Problems of heat, starting of the vehicle, rough idle, etc., have been present and are being resolved when they appear.

Staff and Board members have driven representative vehicles and found problems present, and others did not. Our public survey of owners of 1965 and 1966 vehicles resulted generally in the same complaints being expressed but perhaps with slightly greater frequency on the 1966 cars equipped with exhaust control systems.

Emissions controlled

As has been reported periodically, the emissions controlled due to the installation of exhaust control systems on 800,000 1966-model vehicles, have resulted in control of 110,000 gallons of gasoline each day in the State of California, and more than 1600 tons of carbon monoxide each day. This control in conjunction with crankcase emission control results in 400,000 gallons of gasoline each day being kept from the skies of California and in many cases being used by the motorists at a considerable savings. Certainly these accomplishments will increase with the passage of time.

Recommendation

It is therefore my recommendation as Executive Officer that under the provisions of Section 24386(4) of the Health and Safety Code of the State of California, this Board issue certificates of approval to those manufacturers who have requested certification for their systems or amended certifications to their existing applications as required by Resolution 64-30 which limited the 1966 certification to only one model year.

Exemptions

It is my pleasure to report that there are no exemptions requested of the MVPCB for 1967 model domestic vehicles. Those vehicle manufacturers and assemblers who had originally requested exemptions such as, ambulances and other specialized equipment have met with the staff, and it has been determined

that there is no justification to exempt any of these vehicles. Class A vehicles (foreign) have been granted an exemption by prior action of this Board for the one model year of 1967. Indications from the foreign manufacturers are that they will be able to comply for the 1968 model year, and be able to supply to the California market, vehicles in compliance with the State standards and the requirements established by this Board.

It is anticipated therefore that every vehicle sold in the State of California, whether from a foreign manufacturer or not, will be equipped with exhaust and crankcase emission control systems by the 1968 model year.

B

California and Federal Motor Vehicle Emission Standards [1]

California Department of Public Health, Bureau of Air Sanitation, July, 1966

On March 30, 1966, the Federal Government adopted standards for exhaust and crankcase emissions. These standards are to be effective beginning with 1968 model cars. The purpose of this report is to evaluate quantitatively what the impact would be on vehicle emissions if California were to adopt standards similar to the Federal ones for small vehicles. The effects on emissions in Los Angeles will be used as examples. Because the Federal standards pertain only to hydrocarbon and carbon monoxide, consideration will be mainly concerned with these two contaminants.

In California, emission standards have been established for exhaust hydrocarbons, carbon monoxide, oxides of nitrogen, smoke, odor and irritation; for hydrocarbons in crankcase emissions; and evaporative losses. In 1970, more stringent standards for exhaust hydrocarbons and carbon monoxide will be in effect in the state.

Federal exhaust standards for Class A vehicles are more liberal than the corresponding Califorina standards. The Federal crankcase standard, on the other hand, permits no emissions while California limts emissions amounting to 0.1% supplied fuel. Both crankcase emission standards, however, have the effect of requiring devices that are virtually 100% effective. Table I compares the standards established by the two governmental levels.

The effect of more lenient standards for Class A cars on the California program is dependent on the percent of these vehicles in the state's total vehicle population. Direct information on vehicle distribution by engine displacement is not available either for the nation or the state on the basis of registration figures. The distribution shown in Table II was derived from data contained in the 1965 "Automotive News Almanac", which gives numbers of cars in operation in California by model year and make. Estimation of engine class was made by the Department for each model and make according to the published data. The summation of this information yields the percentage of each engine class. Foreign cars were similarly estimated from reported figures for California in the Almanac.

Table I.—*Comparison of California and Federal standards*

Source	Class [1]	California			Federal		
		Hydrocarbon parts per million	Carbon monoxide percent	Oxides of Nitrogen parts per million	Hydrocarbon parts per million	Carbon monoxide percent	Oxides of nitrogen parts per million
Exhaust (current standards)	A1	275	1.5	350	(1)	(2)	None.
	A2	275	1.5	350	410	2.3	
	A3	275	1.5	350	350	2.0	
	B	275	1.5	350	275	1.5	
	C	275	1.5	350	275	1.5	
	D	275	1.5	350	275	1.5	
	E	275	1.5	350	275	1.5	
	F	275	1.5	350	275	1.5	
Exhaust (1970 standards)	All classes	180	1.0	350			
Crankcase	do	0.1% supplied fuel.[3]			Permits no crankcase emissions.		
Evaporative emissions	do	6 grams hydrocarbons per day, fuel tank. 2 grams hydrocarbons per soak, carburetor.			None. None.		

[1] See table II for engine displacement.
[2] Exempt.
[3] In effect, requires virtually 100 percent control.

[1] Presented at the August 10, 1966, California Motor Vehicle Pollution Control Board meeting, Los Angeles, California.

TABLE II.—*California motor vehicle population distribution by class*

Class	Displacement cubic inches	Percent of total	Estimated State total [1]
A1	<50	0.3	30,000
A2	50–100	[2] 6.9	694,000
A3	100–140	.8	81,000
B	140–200	9.0	906,000
C	200–250	30.0	3,020,000
D	250–300	25.0	2,516,000
E	300–375	18.0	1,812,000
F	>375	10.0	1,007,000

[1] Based on 1965 year-end California registered motor vehicle population of 10,065,000, rounded off to nearest thousand as reported by department of motor vehicles.

[2] Volkswagen comprises 51 percent of class A2, or 42 percent of the combined classes of A1, A2, and A3 vehicles (nationally).

Source: Derived from Automotive News Almanac, 1965 issue, and department of motor vehicles.

The effects of the Federal Standards

A report entitled "Effects of Control Programs on the Emissions of Hydrocarbon and Carbon Monoxide in Los Angeles County" was presented to the California Motor Vehicle Pollution Control Board in January, 1966, by the Department. The report presented data showing the hydrocarbon and carbon monoxide emissions from 1940 to the present with projections to 1980 under the California program. Two charts depicting those data are redrawn, Figure 1 showing hydrocarbon and Figure 2 showing carbon monoxide with an additional curve showing the effect of the less strict standard for Class A cars. The differences between the controls required by the Federal and California standards are slight at present; but unless the Federal Government adopts stricter standards which will be effective in California, those differences will be substantial after 1970. With the advent of evaporative control in California, Federal standards will also be needed for these sources to achive the same degree of control. Table III shows the emissions under the California and the present Federal standards for future years.

By 1980 the projected uncontrolled emisions of hydrocarbons will be 4140 tons/day (see Fig. 1, p. 560) and 18,000 tons/day for carbon monoxide (see Fig. 2, p. 561). The contemplated reduction under the Federal program of crankcase and exhaust controls by 1980 will amount to 2700 tons/day or 65% for hydrocarbons while carbon monoxide will be reduced 9750 tons/day or 54%. By contrast, California's control program of crankcase, stricter exhaust and evaporative controls is estimated to effect reductions of hydrocarbons by 1980 of 3400 tons/day or 82%, and 12,480 tons/day or 69% for carbon monoxide.

Standards based on quantity of emissions

On September 15, 1965, the Department reported to the Motor Vehicle Pollution Control Board on the feasibility of exhaust standards effective in 1970 based on quantity of emissions. One approach was to apply a given degree of reduction to the average quantity of emissions from each class of vehicle. Under this scheme the 1970 concentration standards for Class A vehicles would be approximately the same as those recently adopted by the Federal Government. In order to meet the objective of rolling back the hydrocarbon emissions to the 1940 level, the standard for vehicles in classes B through F would be approximately 160 ppm.

This analysis does not include oxides of nitrogen emissions from exhaust because the Federal Government has not established standards for these compounds. The concentrations of oxides of nitrogen in the exhaust from different classes of vehicles do not differ greatly. If a standard is established based on quantity emissions, the allowable concentration will be inversely proportional to exhaust flow rate. Class A vehicles, with lower exhaust volumes, would be permitted higher oxides of nitrogen concentration in their exhausts, while vehicles with large engines and high exhaust flow rates would be allowed proportionately lower concentrations of exhaust nitrogen oxides.

TABLE III.—*Motor vehicle emissions in Los Angeles under different standards*

Yearend	Hydrocarbons, tons/day			Carbon monoxide, tons/day		
	California [1] standard	Federal [2] standard	Difference	California [1] standard	Federal [2] standard	Difference
1970, without evaporation control	1,690	1,730	40	9,320	9,620	300
1975, without evaporation control	1,360	1,510	150	7,110	8,530	1,420
1975, with evaporation control	1,160	1,510	350			
1980, without evaporation control	1,150	1,440	290	5,520	8,250	2,730
1980, with evaporation control	740	1,440	700			

[1] Assuming emissions will comply with standards now adopted in California.
[2] Assuming no change in the present Federal standards.

Figure 1

EFFECT OF FEDERAL AND CALIFORNIA CONTROL PROGRAMS ON HYDROCARBON EMISSIONS FROM MOTOR VEHICLES IN LOS ANGELES COUNTY, 1940-1980

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH
BUREAU OF AIR SANITATION
7-12-66

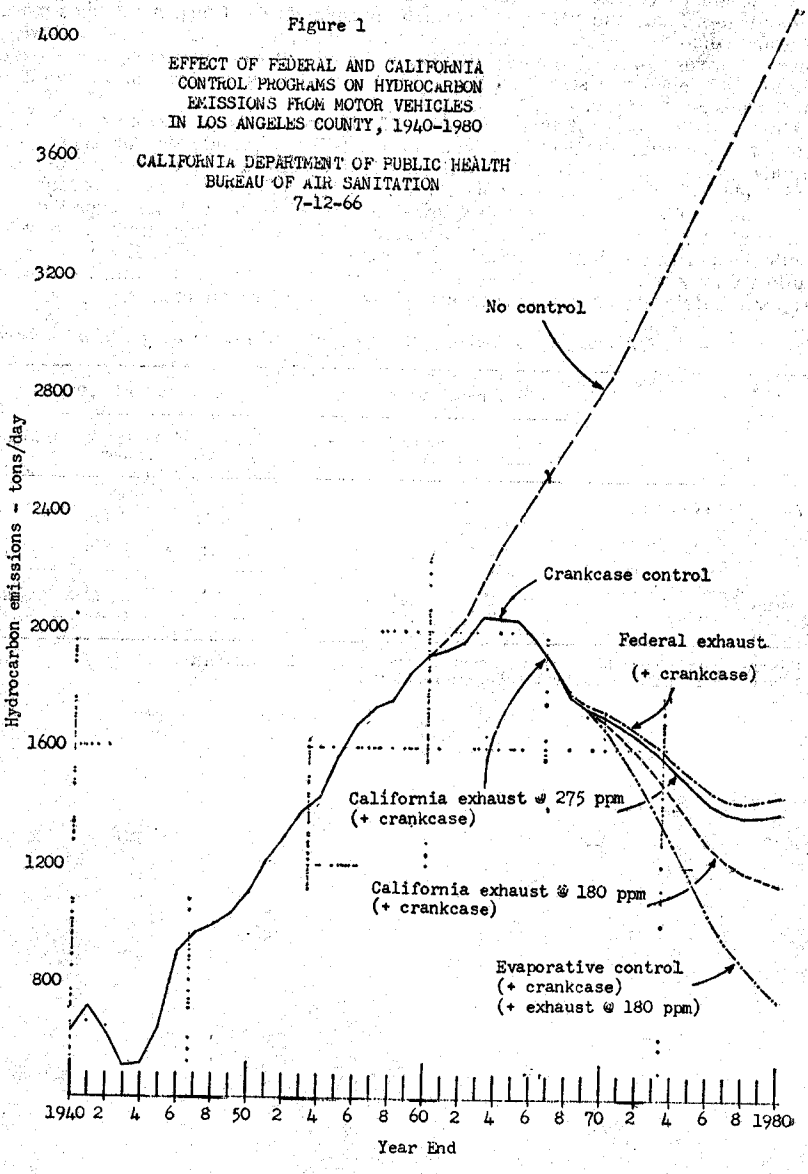
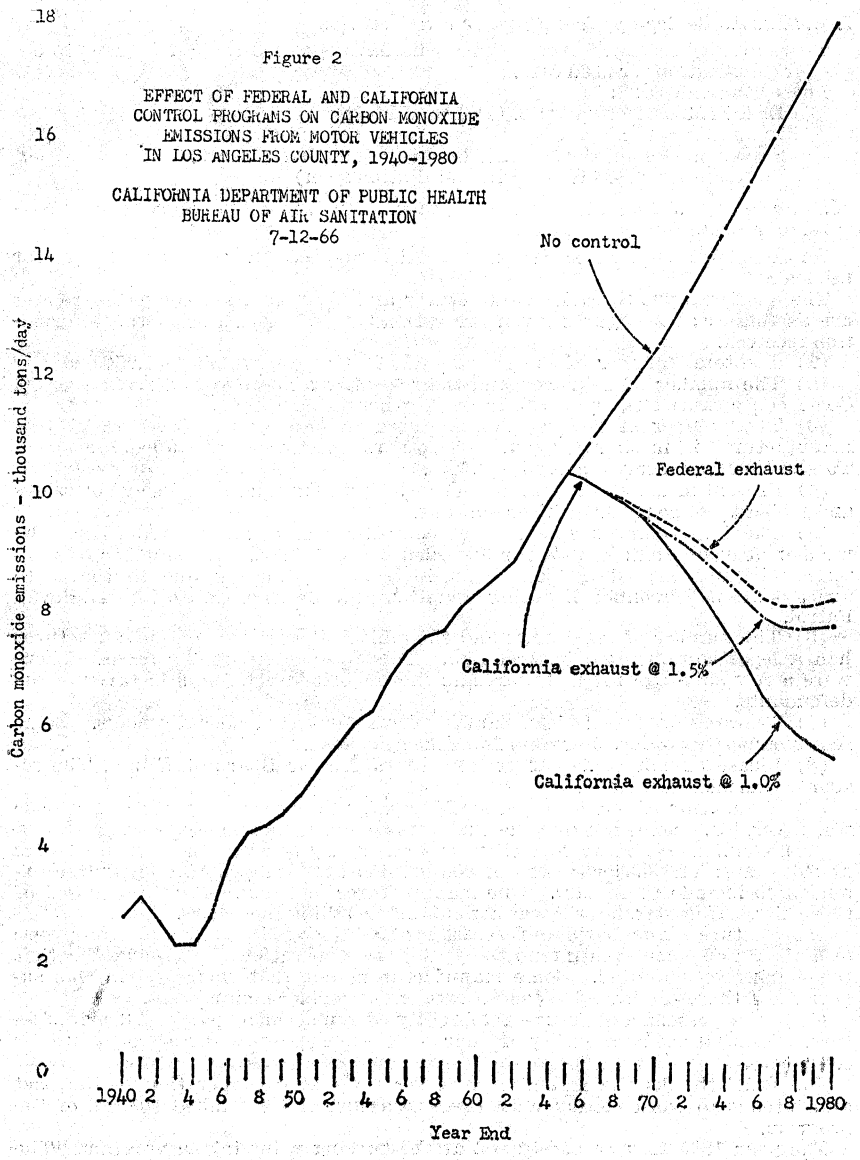


Figure 2

EFFECT OF FEDERAL AND CALIFORNIA CONTROL PROGRAMS ON CARBON MONOXIDE EMISSIONS FROM MOTOR VEHICLES IN LOS ANGELES COUNTY, 1940-1980

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH
BUREAU OF AIR SANITATION
7-12-66



C

STATE OF CALIFORNIA MOTOR VEHICLE POLLUTION CONTROL BOARD

STAFF REPORT ON CRANKCASE SYSTEMS, AUGUST 10, 1966

I. Crankcase device applicants under consideration

There are at present four companies who have signified their intentions to apply for certification for used cars.

These companies are:

Eichlin Manufacturing Co. (Installed Fleet)
F & J Control Filters (Partial Installation of Fleet)
Salyer Sta-Ready Filter Co. (Partial Installation of Fleet)
Co-Recti-Fire Co. (Will begin Installation soon)

II. The board on May 11, 1966 requested a status report on the crankcase control program

On June 15, 1966 a letter was sent to all crankcase device manufacturers for used vehicles.

The questions put to each manufacturer and their guarded composite replies are as follows: The figures given are estimated as deduced from the information received.

(1) The total number of sales to July 1, 1966: Approximately 1,750,000.

(2) The number of field men and their location: These varied from 1 to 80. Some concentrated their activities in Northern California.

(3) The number of devices manufactured to date and reserve stock: One manufacturer is in short supply. The others appear to have adequate stock. Total estimated reserve about 150,000 kits.

(4) Present means of Sales Distribution: Most manufacturers use wholesalers and jobbers. Some use franchised stations.

(5) The total number and kind of complaints and their distribution: The number of complaints in 1964 far exceeded those in 1965. The number of complaints in 1965 has decreased to an insignificant number due to the more strict station personnel licensing requirements by the California Highway Patrol.

(6) The number of legal suits and their disposition: Only one manufacturer had a legal suit directed against him. This was settled in his favor. There were a few suits against installers and the majority were found in favor of the defendants.

(7) Training program: Most manufacturers conducted special schools. Some sent instructions to installers and franchised stations.

(8) Please submit copies of product literature for Board staff use: The response was most favorable.

(9) Estimation of public response: Most manufacturers felt that the response was favorable. Some felt that the public was merely following the law.

(10) Opinion as to the feasibility of extending the program to 1950–54 cars at this time: The majority was of the opinion that the program should be extended to include these cars. One manufacturer had inadvertently disposed of these kits. However, he still was not against including these cars.

(11) Future Plans, business forecast for 1967–1968: Most manufacturers were optimistic and some even intend to expand their operations. Only one felt that the market was limited. Some manufacturers felt that their system was superior and therefore intend to concentrate on the replacement market.

(12) The present and future availability of replacement parts: All manufacturers felt that the availability of their replacement parts would be adequate for the future.

The Staff thanks the manufacturers for their kind cooperation in the past and intends to work closely with them to assure the continued success of the program.

The year 1965 may be considered as the turning point in the program. The number of complaints on crankcase device installations received by this office averages about or or two a week and these are mostly due to other causes. The staff wishes to thank the California Highway Patrol for their sincere efforts and cooperation in the qualifying and policing of licensed stations and mechanics. The public has also been alerted to contact the highway patrol directly in the advent of any complaint against an installer or smog device. For the period

from May 15 to June 15, 1966 there were only 18 complaints received by the California Highway Patrol traced to an improper installation.

There are at present two revocation proceedings against licensed stations and one against an installer.

III. Sale of "pseudo" AC and midas valves

A member of our staff has purchased valves which have the appearance of AC and Midas products.

The manufacturer was notified in writing to immediately desist from the sale of these valves in California and that all valves on dealers shelves must be immediately removed.

He was also advised that he has the option to apply for certification if he so desired.

The California Highway Patrol was alerted to be on the lookout for these valves.

IV. Present status of the K & B crankcase emission control device

The K & B Corporation completely redesigned and changed the material used in their Vac-U-Tron valve from steel to plastic.

At a meeting held at the offices of the Motor Vehicle Pollution Control Board on July 8, 1966, between representatives of the company and staff engineers, the following was agreed upon:

1. K & B would run at least 10 cars for the 12,000 mile test to determine the efficiency and durability of their new valves.
2. The system would not be sold to the public until the completion of these tests.

K & B is now running 100 cars on their own for evaluation purposes. They will start the official 12,000 mile tests when they are satisfied with the performance of their modified Vac-U-Tron valve.

V. The following statistics were derived from the best sources available

(a) Status as of February 1966

Number of registered autos and trucks	10,060,000
Number of cars and trucks equipped with crankcase devices:	
State of California	6,139,000
Smog counties only	4,420,000
Number of cars and trucks in smog counties which do not have devices but will require them on transfer (as of August 1966)	1,260,000
Number of out-of-state cars which will require devices in 1966 (usually register at end of year)	114,000
Potential market (balance of 1966)	1,374,000
Number of additional cars and trucks added to the program:	
If all counties were included	1,070,000
If 1950–54 models were included	1,087,000
Total	2,157,000

Hydrocarbons emitted by the 2,157,000 cars through the crankcase: 660,000 pounds per day or 100,000 gallons per day.

Cost to the motorist (at 30 cents a gallon): $30,000 a day or $10,950 000 per year.

Cost of installing crankcase devices on 2,157,000 vehicles, at $15 each: $32,355,000.

The savings on gasoline will therefore pay for the devices in less than 3 years.

(b) Crankcase device installations on used vehicles, Jan. 1, 1964, to July 31, 1966

Installations since Jan. 1, 1964:	
Commercial (1950–54 models)	98,000
Autos (1950–54 models)	116,000
Commercial (1955 and later models)	260,000
Autos (1955 and later models)	1,043,000
Total	1,517,000

Hydrocarbons prevented from escaping to atmosphere from crankcase: 450,000 pounds per day or 68,000 gallons per day.

Savings to motorist at 30 cents a gallon: $20,400 per day or $7,500,000 per year.

VI. Requests for installation instructions for formerly exempt cars 1950–1960 and for out-of-State cars 1961–1965 models.

The staff has received numerous requests from installers for installation instructions for these cars, 1950–1960, which had been formerly exempt and for 1961 thru 1965 out-of-state vehicles seeking registration in California.

The manufacturers have been notified of this situation and the staff intends to work closely with them to assure that proper instructions are available to the installers for these vehicles.

Based on the attached data, we are aware that many of these vehicle owners must have devices installed at time of transfer and in other cases, pre-1955, will desire to install a system to control emissions and secure the other benefits of a crankcase control system, even though the law does not require such action.

D

REPORT ON DIESEL FUEL ADDITIVES AND OTHER MATTERS RELATING TO DIESEL EMISSIONS, AS REQUIRED UNDER SENATE CONCURRENT RESOLUTION NO. 90 INTRODUCED BY SENATOR COLLIER, CHAIRMAN, SENATE COMMITTEE ON TRANSPORTATION

Concurrent Resolution 90 directed the Motor Vehicle Pollution Control Board:

1. To test or cause to be tested various diesel fuel additives to determine compliance with State standards, costs, detrimental side effects, if any, and effect on operation of diesel trucks and buses.

2. To cooperate with the California Highway Patrol to determine if such additives would reduce smoke density on diesel equipment below existing enforcement levels for "excessive smoke."

3. To render a progress report concerning the effectiveness of diesel fuel additives to the Senate Factfinding Committee on Transportation and Public Utilities, and the Assembly Interim Committee on Transportation and Commerce by July 1, 1966.

INTRODUCTION

As a result of emission standards being established by the State Department of Public Health for smoke and odor from motor vehicles, the Motor Vehicle Pollution Control Board has been engaged in several areas of activity to secure compliance with these standards.

In addition to this activity, which is directed toward certifying a device, the staff of the Board has endeavored to secure the cooperation of the petroleum and trucking industries to purposefully accomplish better emission control from diesel vehicles prior to the time, and possibly in lieu of, actual devices.

It is the policy of this Board, and has been in the past in relation to other areas of control, that the primary objective is to secure compliance. If, through cooperative interest, emissions from diesel vehicles can be reduced without the necessity of enforcement of the law, this is by far the best course of action to take.

FUEL ADDITIVES

The principle of utilizing an additive to diesel fuel to eliminate visible emissions has been recognized for many years as a potential means of control. As is discussed in the attached paper to be presented by our Supervising Engineer, at the August SAE meeting in Los Angeles, significant reduction of emissions may be achieved. Due to this reduction and the preponderance of evidence that there is no injury to the engine or significant increase in cost, it appears at this time that an additive will be added to diesel fuel supplied to the California market. The use of this fuel additive should result in effective smoke reduction. Unfortunately, it appears that it will not be added to all diesel fuel marketed, but only as a premium fuel as an addition cost to the trucker if he wants to place the additive in his fuel tank after he has purchased the untreated fuel.

Extensive tests and evaluations by the Lubrizol Corporation and several California petroleum refining companies clearly indicate that no damage, after hundred of thousands of miles, will result to the engine from the use of a fuel additive. The attached report from the Lubrizol Corporation contains data and material relating to their evaluations.

There are two observations and possible objections to the fuel additive approach for diesel smoke suppression. First, the Department of Public Health, although they find no foreseeable injurious effect as a result of fuel additives; feel that to require the use of an additive is, in a sense, requiring something similar to lead in gasoline. It may or may not be a health problem. Basic ingredients of a fuel additive are metals, such as barium and iron, and have the effect of being a combustion improver. There is, however, a residual which results from their use. The best information to date from all sources is that there is no potential problem found in their use. However, it does concern the Department of Public Health that if they were to be required by law, it would be specifying an additional ingredient which may be a potential problem.

The second objection to the additive approach is that since it acts as a combustion improver, increased available horsepower results, and the operator of the vehicle could re-adjust his driving practices and engine adjustments so as to utilize the horsepower, rather than getting the benefit of the smoke reduction. In other words, he would utilize the horsepower rather than allow the additive to

cause a reduction in smoke. The net result would be that the diesel would continue to smoke, but more horsepower would be used by the driver.

Experience with additives indicates that it would be desirbale to have the fuel additive used as an alternative method for smoke reduction. It is inconsistent with established Board policy, however, under existing law, to specify its use since it would appear that it is not a device, as defined in the laws under which this Board must operate.

OTHER AREAS OF EMISSION REDUCTION

As Mr. Brubacher points out in the attached paper, maintenance, driver practices, fuel specifications, engine modifications, and engine derating all have their effect on diesel emission reduction. Through a cooperative campaign with the California Trucking Association, we are endeavoring to inform the trucking industry of the benefits of all of these approaches. We have met, and will continue to meet with representatives of the petroleum industry, in an effort to determine the advisability of securing tighter fuel specifications. We know that quality fuel will help reduce emissions. We also know that if a diesel vehicle's injectors are set for a certain grade of fuel, a change in the fuel may cause he vehicle to emit smoke. As an example, a Los Angeles trucking operator maintains excellent shop facilities, good driver habits are followed by the drivers, and he purchases a quality fuel for his vehicles in Los Angeles. A truck moving from Los Angeles to Redding would re-fuel at that Northern California city. Unless he has available substantially identical fuel, the vehicle may smoke.

In a follow-up report to the Commitee we hope to indicate that a cooperative program between the refinery industry, the trucking industry, and ourselves will be solving this problem.

ENFORCEMENT

As you are well aware, the Legislature, in Senate Resolution 18, directed law enforcement officers within the State of California, and particularly the California Highway Patrol, to increase their efforts in the area of visible smoke emissions. The number of citations issued has indicated that this directive has been given a great deal of support. It is my considered judgment that the strong enforcement now being utilized in the State of California will cause the diesel user to recognize the need to control emissions, and to respond, in the areas mentioned above, to see that they are in compliance with the law.

DIESEL TECHNICAL ADVISORY COMMITTEE

The Diesel Technical Advisory Committee to the Motor Vehicle Pollution Control Board has met, and will meet in the future, in relation to the technical approach to this problem. Interesting observations were made by these technical experts (a list of the Committee is attached) that basically, in the low elevation areas in the State of California, visible diesel emissions can be controlled within existing legal requirements.

A major point of concern, however, was the difficulty, due to reduced oxygen concentrations in the air at higher elevations, of keeping emissions at a low level. The problem is this: We know that oxygen decreases with increase in elevation, because of the decreased density of the air. Since all motor vehicles, including the diesel, rely upon the available oxygen in the air, the combustion process is affected. It may therefore be suggested (and this would again be the subject of future reports to the committee) that an allowance be made for legal emission levels when the vehicle is at higher elevations. As an example, possibly a No. 1 Ringelmann would be used at sea level to 2000 feet; and above 2000 feet a No. 2 Ringelmann. An alternative would be to fit an aneroid control to the engine fuel system. This would hold smoke essentially constant with altitude. However, the fleet operators may object to the resultant slight horsepower decrease at altitude.

To summarize, therefore, in this interim progress report to your committee, considerable effort is being put forth to reduce visible emissions from motor vehicles, particularly the diesel, with significant results. Plans and procedures are being prepared which, as a cooperative effort of all concerned, hopefully will result in a significant reduction in visible smoke. In conjection with this program, enforcement policies are being strongly supported by law enforce-

ment officers. Test procedures and criteria for the evaluation of devices to control emissions are being prepared by the Motor Vehicle Pollution Control Board, in cooperation with the Technical Advisory Committee.

The problem of odor control from diesel vehicles is one of substantial difficulty, both as to its definition and as to its control. Nevertheless, we are recognizing this fact, and through the cooperative effort of the committee and the Board, will establish satisfactory means of evaluating such a control system.

The results of this effort will hopefully be immediate reduction of visible emissions and the necessary administrative-procedural means to evaluate any device or system that is submitted to this Board by private industry that will meet the standards established by the State Department of Public Health.

E

State of California Motor Vehicle Pollution Control Board

Administrative Code Provisions, Title 13, in Support of Chapter 3, Division 20, Health and Safety Code

CALIFORNIA ADMINISTRATIVE CODE: TITLE 13, CHAPTER 3, SUBCHAPTER 1

Sec.
2000. Requirements.
2001. Plans Submitted.
2002. State Standards.
2003. Other Criteria.
2004. Motor Vehicle Classification.
2005. Board Action.
2006. Notification.
2007. Device Identification.

Article 1. Certification of crankcase emission control devices

2000. *Requirements.*—Crankcase emission control devices will be certified for approval pursuant to Health and Safety Code Section 24386(4) only if such devices operate within the standards set by the State Department of Public Health pursuant to Section 426.5, Health and Safety Code, and meet the criteria adopted by the Motor Vehicle Pollution Control Board pursuant to Health and Safety Code Section 24386(3).

Note: Authority cited for Chapter 3: Sections 24386, 24387 and 24388, Health and Safety Code.

2001. *Plans Submitted.*—Any person seeking a certificate of approval by the Board for any device to control crankcase emissions from motor vehicles shall submit plans thereof to the Board at its office in the Subway Terminal Building, Suite 1085, 417 South Hill St., Los Angeles, California, 90013. Such plans shall be accompanied by reliable test data indicating compliance with the California Standards for Motor Vehicle Crankcase Emissions adopted by the State Board of Public Health December 2, 1960, and with criteria as established by the Board as contained in this article.

2002. *State Standards.*—Every device controlling crankcase emissions from motor vehicles receiving a certificate of approval from the Motor Vehicle Pollution Control Board shall meet the standards as established by the State Department of Public Health in Title 17 of the California Administrative Code, Chapter 5, Subchapter 5, Article 1, Section 30530.

2003. *Other Criteria.*—Every device controlling crankcase emissions from motor vehicles receiving a certificate of approval from the Motor Vehicle Pollution Control Board shall meet the following criteria:

(a) Be so designed as to have no adverse effect on engine operation or vehicle performance.

(b) Operate in a safe manner.

(c) Have sufficient durability so as to operate within State Standards and other Motor Vehicle Pollution Control Board Criteria for at least 12,000 miles without maintenance.

The effective date of this amendment shall be the 1966 model year or October 1, 1965.

(d) Operate in such a manner so as not to create excessive heat, noise, or odor beyond the standard characteristic of the motor vehicle without such device.

(e) The purchase or cost of installation of such device shall not constitute an undue cost burden to the motorist.

(f) Installation of such device shall not create or contribute to a noxious or toxic effect in the ambient air.

(g) The adequacy of methods of distribution, the financial responsibility of the applicant, and other factors affecting the economic interests of the motoring public shall be evaluated and determined satisfactory to protect the motorists.

2004. *Motor Vehicle Classification.*—Motor vehicles for which crankcase emission control devices will be certified are divided into the following classifications:

(a) Under 140 cubic inches engine displacement.
(b) 140–200 cubic inches engine displacement.
(c) 200–250 cubic inches engine displacement.

(d) 250–300 cubic inches engine displacement.
(e) 300–375 cubic inches engine displacement.
(f) Over 375 cubic inches engine displacement.
(g) Motor vehicles which because of unusual engine design by the manufacturer require special control methods for crankcase emission regardless of engine displacement.

2005. *Board Action.*—The board upon review and evaluation of appropriate tests shall make a finding at a duly called public meeting as to whether a specific device for control of crankcase emissions meets the standards and criteria specified in this article. If a device is found to be in compliance, a certificate of approval will be issued for its operation on a classification or classifications of vehicle.

2006. *Notification.*—When two or more devices have been granted a certificate of approval for a classification of motor vehicle, the Board shall notify the Department of Motor Vehicles by submission of an appropriate Board Resolution within 30 days of the date of their action.

2007. *Device Identification.*—(a) The device shall be permanently and visibly marked with the trademark or name, and the model designation, in letters and/or numerals at least $\frac{1}{16}$ inch in height. The manufacturer's initials will be acceptable as the name, and trademarks shall include at least one letter $\frac{1}{16}$ inch or more in height.

(b) The required markings shall be die stamped or molded on each major component, or imprinted on a permanent name plate on each major component of the device or, as determined necessary by the Executive Officer of the Motor Vehicle Pollution Control Board.

(c) Samples of working models may be required by the Motor Vehicle Pollution Control Board as needed for inspection and approval and may be retained by the Board for reference and comparison purposes.

(d) This section shall be immediately applicable to devices approved after the effective date of this regulation. Devices approved prior to that time for used motor vehicle application must comply with the provisions of this section by January 1, 1964. Devices approved for new vehicle installation at the factory must comply by the time of the 1965 model year or October 1, 1964.

Article 2. Certification of exhaust emission control devices for controlling hydrocarbons and carbon monoxide

2100. *Requirements.*—Exhaust emission control devices for controlling hydrocarbons and carbon monoxide will be certified for approval pursuant to Health and Safety Code Section 28386(4) only if such devices operate within the Standards for said pollutants set by the State Department of Public Health pursuant to Section 426.5 Health and Safety Code, and meet the criteria adopted by the Motor Vehicle Pollution Control Board pursuant to Health and Safety Code Section 24386(3).

2101. *Plans Submitted.*—Any person seeking a certificate of approval by the Board for any device to control exhaust emissions from motor vehicles shall submit plans thereof to the Board at its office in the Subway Terminal Building, 417 South Hill Street, Los Angeles. Such plans shall be accompanied by reliable test data indicating compliance with the California Standards for Motor Vehicle Exhaust Emissions adopted by the State Department of Public Health pursuant to Section 426.5 of the Health and Safety Code, and with criteria as established by the Board as contained in this article.

2102. *State Standards.*—Every device controlling exhaust emissions from motor vehicles receiving a certificate of approval from the Motor Vehicle Pollution Control Board shall meet the Standards for specified pollutants as established by the State Department of Public Health in Title 17 of the California Administrative Code, Chapter 5, Subchapter 5, Article 1, Section 30520.

2103. *Other Criteria.*—No device controlling exhaust emissions from motor vehicles shall receive a certificate of approval from the Motor Vehicle Pollution Control Board unless it meets the following criteria:

(a) The purchase or cost of installation of such device shall not constitute an undue cost burden to the motorist.

(b) Such device shall operate on a designated classification of motor vehicle, as specified in Section 2104, so that, with vehicle maintenance which is characteristic of general usage by the motoring public, its average emissions are within the limits established by the State Standards.

(c) Such device shall operate in a safe manner and so that the device will not result in any unsafe condition resulting from excessive heat applied to the floorboards, hydraulic brake cylinders, brake lines, gasoline tank, fuel pump, fuel lines, transmission or other components of the motor vehicle or otherwise result in an unsafe motor vehicle.

(d) Malfunction or failure of the device shall not endanger life or property.

(e) Such device shall not malfunction or fail under the stress or backfire in the exhaust system.

(f) Such device shall not allow exhaust products of the motor vehicle to enter the passenger compartment in a volume beyond the volume characteristic of the motor vehicle with a standard exhaust system.

(g) Heat emanating from an operating device shall not create a hazard to persons or property who are in close proximity to the motor vehicle.

(h) Such device shall not cause an increase in fuel consumption or a decrease in vehicle performance beyond the limits established in the Fleet & Life Testing Procedures of the Motor Vehicle Pollution Control Board.

(i) Such device shall not be permanently impaired by the variety of severe motor vehicle operating conditions frequently encountered in California including heavy rains, mountain and desert driving, and other severe operating conditions.

(j) Such device shall operate in a manner so as not to create excessive noise or odor beyond the standard characteristics of the motor vehicle equipped with a standard exhaust system; nor should the installation of such device create a noxious or toxic effect in the ambient air.

(k) Such device shall be so designed as to have no adverse effect on engine operation or vehicle performance.

(l) The adequacy of methods of distribution, the financial responsibility of the applicant, and other factors affecting the economic interest of the motoring public shall be evaluated and determined satisfactory to protect the motorists.

2104. *Motor Vehicle Classification.*—Motor vehicles for which exhaust emission control devices will be certified are divided into the following classifications:

(a) (1) Under 50 cubic inches engine displacement.
(a) (2) 50–100 cubic inches engine displacement.
(a) (3) 100–140 cubic inches engine displacement.
(b) 140–200 cubin inches engine displacement.
(c) 200–250 cubic inches engine displacement.
(d) 250–300 cubic inches engine displacement.
(e) 300–375 cubic inches engine displacement.
(f) Over 375 cubic inches engine displacement.
(g) Motor vehicles which because of engine design by the manufacturer include or require special control methods for exhaust emission regardless of engine displacement.

2105. *Board Action.*—The Board upon review and evaluation of appropriate tests shall make a finding at a duly called public meeting as to whether a specific device for control of exhaust emissions meets the Standards and criteria specified in this article. If a device is found to be in compliance, a certificate of approval will be issued for its operation on a classification or classifications of vehicle.

2106. *Notification.*—When two or more devices have been granted a certificate of approval for a classification of motor vehicle, the Board shall notify the Department of Motor Vehicles by submission of an appropriate Board Resolution.

2107. *Device Identification.*—(a) The device shall be permanently and visibly marked with the trademark or name, and the model designation, in letters and/or numerals at least ⅛ inch in height. The manufacturer's initials will be acceptable as the name, and trademarks shall include at least one letter ⅛ inch or more in height.

(b) The required markings shall be die stamped or molded on each major component, or imprinted on a permanent name plate on each major component of the device or, as determined necessary by the Executive Officer of the Motor Vehicle Pollution Control Board.

(c) Samples of working models may be required by the Motor Vehicle Pollution Control Board as needed for inspection and approval and may be retained by the Board for reference and comparison purposes.

(d) The effective date of this section shall be January 1, 1965.

Article 3. Certification of exhaust emission control devices for controlling oxides of nitrogen

2200. *Requirements.*—Exhaust emission control devices for controlling oxides of nitrogen will be certified for approval pursuant to Health and Safety Code Section 24386(4) only if such devices operate within the Standards for said pollutants set by the State Department of Public Health pursuant to Section 426.5 Health and Safety Code, and meet the criteria adopted by the Motor Vehicle Pollution Control Board pursuant to Health and Safety Code Section 24386(3).

2201. *Plans Submitted.*—Any person seeking a certificate of approval by the Board for any device to control exhaust emissions from motor vehicle shall submit plans thereof to the Board at its office in the Subway Terminal Building, 417 South Hill Street, Los Angeles. Such plans shall be accompanied by reliable test data indicating compliance with the California Standards for Motor Vehicle Exhaust Emissions adopted by the State Department of Public Health pursuant to Section 426.5 of the Health and Safety Code, and with criteria as established by the Board as contained in this article.

2202. *State Standards.*—Every device controlling exhaust emissions from motor vehicles receiving a certificate of approval from the Motor Vehicle Pollution Control Board shall meet the Standards for specified pollutants as established by the State Department of Public Health in Title 17 of the California Administrative Code, Chapter 5, Subchapter 5, Article 1, Section 30520.

2203. *Other Criteria.*—No device controlling exhaust emissions from motor vehicles shall receive a certificate of approval from the Motor Vehicle Pollution Control Board unless it meets the following criteria:

(a) The purchase or cost of installation of such device shall not constitute an undue cost burden to the motorist.

(b) Such device shall operate on a designated classification of motor vehicle, as specified in Section 2104, so that with vehicle maintenance which is characteristic of general usage by the motoring public, its average emissions are within the limits established by the State Standards.

(c) Such device shall operate in a safe manner and so that the device will not result in any unsafe condition resulting from excessive heat applied to the floorboard, hydraulic brake cylinders, brake lines, gasoline tank, fuel pump, fuel lines, transmission or other components of the motor vehicle or otherwise result in an unsafe motor vehicle.

(d) Malfunction or failure of the device shall not endanger life or property.

(e) Such device shall not malfunction or fail under the stress of backfire in the exhaust system.

(f) Such device shall not allow exhaust products of the motor vehicle to enter the passenger compartment in a volume beyond the volume characteristic of the motor vehicle without such a device.

(g) Heat emanating from an operating device shall not create a hazard to persons or property who are in close proximity to the motor vehicle.

(h) Such device shall not cause an increase in fuel consumption or a decrease in vehicle performance beyond the limits established in the Fleet & Life Testing Procedures of the Motor Vehicle Pollution Control Board.

(i) Such device shall not be permanently impaired by the variety of severe motor vehicle operating conditions frequently encountered in California including heavy rains, mountain and desert driving, and other severe operating conditions.

(j) Such device shall operate in a manner so as not to create excessive noise or odor beyond the standard characteristics of the motor vehicle equipped with a standard exhaust system; nor should the installation of such device create or contribute to a noxious or toxic effect in the ambient air, including emissions of hydrocarbons and carbon monoxide which shall not be beyond the emissions of said pollutants from a certifiable exhaust emission control device for controlling said pollutants.

(k) Such device shall be so designed as to have no adverse effect on engine operation or vehicle performance.

(l) The adequacy of methods of distribution, the financial responsibility of the applicant, and other factors affecting the economic interest of the motoring public shall be evaluated and determined satisfactory to protect the motorists.

2204. *Motor Vehicle Classification.*—Motor vehicles for which exhaust emission control devices will be certified are divided into the following classifications:

(a) (1) Under 50 cubic inches engine displacement.
(a) (2) 50–100 cubic inches engine displacement.
(a) (3) 100–140 cubic inches engine displacement.
(b) 140–200 cubic inches engine displacement.
(c) 200–250 cubic inches engine displacement.
(d) 250–300 cubic inches engine displacement.
(e) 300–375 cubic inches engine displacement.
(f) Over 375 cubic inches engine displacement.
(g) Motor vehicles which because of engine design by the manufacturer include or require special control methods for exhaust emission regardless of engine displacement.

2205. *Board Action.*—The Board upon review and evaluation of appropriate tests shall make a finding at a duly called public meeting as to whether a specific device for control of exhaust emissions meets the Standards and criteria specified in this article. If a device is found to be in compliance, a certificate of aproval will be issued for its operation on a classification or classifications of vehicle.

2206. *Notification.*—When two or more devices have been granted a certificate of approval for a classification of motor vehicle, the Board shall notify the Governor and the State Legislature by submission of an appropriate Board Resolution.

2207. *Device Identification.*—(a) The device shall be permanently and visibly marked with the trademark or name, and the model designation, in letters and/or numerals at least ⅛ inch in height. The manufacturer's initials will be acceptable as the name, and trademarks shall include at least one letter ⅛ inch or more in height.

(b) The required markings shall be die stamped or molded on each major component, or imprinted on a permanent name plate on each major component of the device or, as determined necessary by the Executive Officer of the Motor Vehicle Pollution Control Board.

(c) Samples of working models may be required by the Motor Vehicle Pollution Control Board as needed for inspection and approval and may be retained by the Board for reference and comparison purposes.

Article 4. Identical devices

2300. *Defined.*—An "identical device" is a device identical in all respects, including manufacture, installation and operation, with a device which has been certified by the Motor Vehicle Pollution Control Board pursuant to Health and Safety Code Section 24386 (4) but which is manufactured by a person other than the original manufacturer of the "certified device."

2301. *Proof of Identical Device.*—Any person intending to manufacture an identical device shall first submit proof to the Motor Vehicle Pollution Control Board that said device is an identical device as defined in Section 2200, supra. Such proof shall include the following:

1. Statement of principle of operation of the device.
2. Design drawings including materials and specifications.
3. Installation drawings.
4. Sample device.
5. Other material as deemed necessary for evaluation by the Executive Officer.

2302. *Subject to Original Certification.*—An identical device is subject to and dependent upon the original application and certification of approval on which it is based.

2303. *Evaluation.*—The board, after review and evaluation of such proof and other date shall make a finding as to whether or not the proposed device is in fact identical to that which received prior approval.

2304. *Notification.*—When a device has been approved as an identical device, the Board shall notify the Department of Motor Vehicles and the California Highway Patrol by submission of an appropriate Board Resolution within 30 days of the date of their action.

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CHAPTER 3, DIVISION 20 OF THE HEALTH AND SAFETY CODE OF CALIFORNIA

Article 1. Application

24378. The Legislature finds and declares:

(a) That the emission of pollutants from motor vehicles is a major contributor to air pollution in many portions of the State;

(b) That the control and elimination of such pollutants is of prime importance for the protection and preservation of the public health and well-being, and for the prevention of irritation to the senses, interference with visibility, and damage to vegetation and property.

(c) That, as the Department of Public Health has established standards for air quality and for emissions of contaminants from motor vehicles pursuant to Section 426.1 and 426.5, the State has a responsibility to establish uniform procedures for compliance with these standards.

24379. (a) As used in this chapter the following terms shall be construed as defined in the Vehicle Code:

(1) Commercial vehicle
(2) Implement of husbandry
(3) Motor vehicle
(4) Motor-driven cycle
(5) Used vehicle
(6) Passenger vehicle

(b) As used in this chapter, "motor vehicle pollution control device" means equipment designed for innstallation on a motor vehicle for the purpose of reducing the pollutants emitted from the vehicle, or a system or engine modification on a motor vehicle which causes a reduction of pollutants emitted from the vehicle.

(c) As used in this chapter, "certified device" means a motor vehicle pollution control device for the control of emissions of pollutants from a vehicle, including, but not limited to, the exhaust system, the crankcase, the carburetor, and the fuel tank, for which standards have been set by the state department under Section 426.5 and for which a certificate of approval has been issued by the Motor Vehicle Pollution Control Board. Whenever under this chapter or any other law a motor vehicle is required to be equipped with a certified device, such requirement refers to the certified device for the control of the specified pollutants from the particular source involved.

24381. The provisions of this chapter shall not apply to any motor vehicle manufactured in the year 1938 or prior thereto, if such motor vehicle is operated or moved over the highway solely for the purpose of taking it to a place for historical exhibition or other similar purpose.

Article 2. Motor Vehicle Pollution Control Board

24383. There is in the State Department of Public Health a Motor Vehicle Pollution Control Board. The board shall be responsible directly to the Governor. Administrative services for the board shall be provided by the State Department of Public Health. The board shall consist of 13 members, nine of whom shall be appointed by the Governor with the consent of the Senate, and four shall be the following officers of the State, or their nominees: Director of Public Health, Director of Agriculture, Commissioner of the California Highway Patrol, and Director of Motor Vehicles.

24384. (a) Of the nine members originally appointed by the Governor, three shall be appointed to serve until July 1, 1962, three shall be appointed to serve until July 1, 1963, and three shall be appointed to serve until July 1, 1964.

Thereafter, all members shall be appointed for a term of four years. All members shall hold office until the appointment of their successors. Any vacancies shall be immediately filled by the Governor for the unexpired portion of the terms in which they occur.

(b) Members of the Motor Vehicle Pollution Control Board shall serve without compensation, but each member shall be reimbursed for his necessary traveling and other expenses incurred in the performance of his official duties.

(c) The members of the board appointed by the Governor shall be selected in such a fashion that the interests of various affected groups throughout the State, including agriculture, labor, organizations of motor vehicle users, the motor vehicle industry, science, air pollution control officials and the general public are represented to the fullest extent possible.

24385. The Motor Vehicle Pollution Control Board shall select annually from its membership a chairman and vice chairman. Only those members who have been appointed by the Governor shall be eligible for these offices.

24385.5 All meetings of the board shall be open and public and all persons shall be permitted to attend any meetings of the board.

24386. The Motor Vehicle Pollution Control Board shall have the powers and authority necessary to carry out the duties imposed on it by this chapter, including but not limited to, the following:

(1) To adopt rules and regulations in accordance with the provisions of the Administrative Procedure Act (commencing at Section 11370 of the Government Code), necessary for proper execution of the powers and duties granted to, and imposed upon the board by this chapter.

(2) To employ such technical and other personnel as may be necessary for the performance of its powers and duties.

(3) To determine and publish the critetria for approval of motor vehicle pollution control devices. In determining the criteria the board shall take into consideration the cost of the device and its installation, its durability, the ease and facility of determining whether the device, when installed on a motor vehicle, is properly functioning, and any other factors which, in the opinion of the board, render such a device suitable or unsuitable for the control of motor vehicle air pollution or for the health, safety, and welfare of the public.

(4) To issue certificates of approval for any motor vehicle pollution control device where, after being tested by the board or tested and recommended by a laboratory designated by the board as an authorized vehicle pollution control testing laboratory, the board finds that the device operates within the standards set by the state department under Section 426.5 and meets the criteria adopted under subdivision (3) of this section; provided that no certificate of approval shall be issued for any device required by subdivision (d) of Section 24390 of this code if:

(a) The cost of such device, including installation, is more than sixty-five dollars ($65);

(b) The annual maintenance cost of the device, including any adjustment necessary for its proper operation in order to meet the standards set pursuant to Section 426.5, is likely to exceed fifteen dollars ($15) a year; or

(c) The device does not equal or exceed the performance criteria established by the Motor Vehicle Pollution Control Board for devices for new motor vehicles or, in the alternative, have an expected useful life of 50,000 miles of operation.

(5) To exempt from Article 3 of this chapter designated classifications of motor vehicles for which certified devices are not available, and motor vehicles whose emissions are found by appropriate tests to meet state standards without additional equipment, and motor-driven cycles, implements of husbandry, and vehicles which qualify for special license plates under Section 5004 of the Vehicle Code.

(6) To revoke, suspend, or restrict a certificate of approval previously issued or an exemption previously granted, upon a determination by the Board that the device or motor vehicle no longer operates within the standards set by the state department under Section 426.5 or no longer meets the criteria adopted under subdivision (3) of this section or no longer should be exempted. Provided that once any motor vehicle is equipped with a certified device it shall not thereafter be deemed to be in violation of this chapter or Section 27156 of the Vehicle Code because a certificate of approval for such device is subsequently revoked, suspended, or restricted, and replacement parts for such device may continue to be supplied and used for such vehicle, unless such revocation, suspension or restriction of a certificate of approval is based upon a finding that the certified device has been found to be unsafe in actual use or is otherwise mechanically defective, in which event such motor vehicle must be brought into compliance with this chapter within 30 days after such finding.

(7) Proceedings under this chapter with respect to the denial of applications for the issuance of certificates of approval or the granting of exemptions, or for the revocation, suspension, or restriction of certificates of approval previously issued, or exemptions previously granted, by the board shall be conducted in accordance with the provisions of Chapter 5 (commencing with Section 11500), Part 1, Division 3, Title 2 of the Government Code, and the board shall have all the powers granted therein.

24386.1 The Motor Vehicle Pollution Control Board may issue permits for the testing of experimental motor pollution control devices installed in motor vehicles.

24386.2 Any manufacturer of a device required by subdivision (d) of Section 24390 of this code shall, as a condition to certification of such device by the board, agree that so long as only one such device is certified by the board such manufacturer is made available for sale to the public, the board shall, taking into consideration the cost of manufacturing the device and the manufacturer's suggested retail price, and in order to protect the public interest, determine the fair and reasonable retail price of such device and may require, as a condition to continued certification of such device, that the retail price of such device, including installation, not exceed such price as determined by the board. In either event the retail price so determined by the board for a device required by subdivision (d) of Section 24390 may be less than, but shall not be more than, sixty-five dollars ($65) per vehicle.

24386.5 The Motor Vehicle Pollution Control Board shall submit a report to the Governor and the Legislature not later than 10 calendar days following the commencement of each general session of the Legislature covering the board's recommendations concerning such legislation and other action as is necessary for the implementation and enforcement of this chapter. The board shall submit its first report to the Governor and the Legislature at the 1961 General Session.

24387. The Motor Vehicle Pollution Control Board shall adopt regulations specifying the manner in which a motor vehicle pollution control device shall be submitted for testing and certification.

24388. Whenever the Motor Vehicle Pollution Control Board issues certificates of approval for two or more devices for the control of emissions of pollutants from a particular source of emissions from motor vehicles for which standards have been set by the state department under Section 426.5, it shall so notify the Department of Motor Vehicles.

Article 3. Certification, sale and installation of motor vehicle pollution control devices

24390. (a) Every 1966 or later year model motor vehicle subject to registration in this state shall be equipped with a certified device or devices to control emission of pollutants from the crankcase and exhaust.

(b) On and after December 1, 1965, every motor vehicle of 1963 or later year model subject to registration in this state shall be equipped with a certified device to control the emission of pollutants from the crankcase.

(c) Every motor vehicle of 1955 through 1962 year model subject to registration in this state upon transfer of ownership and registration to an owner whose residence is in a county or portion of a county within an air pollution control district which may function and exercise its powers, shall be equipped with a certified device to control the emission of pollutants from the crankcase.

(d) Every motor vehicle of 1955 through 1965 year model subject to registration in this state upon transfer of ownership and registration to an owner whose residence is in a county or portion of a county within an air pollution control district which may function and exercise its powers, shall be equipped with a certified device to control the emission of pollutants from the exhaust.

(e) The provisions of subdivisions (a), (b), (c), and (d) of this section shall not be applicable to any of the following:

(1) Any motor vehicle or class of motor vehicles exempted by the Motor Vehicle Pollution Control Board.

(2) Any motor-driven cycle, implement of husbandry or vehicle which qualifies for special plates under Section 5004 of the Vehicle Code.

(f) The provisions of subdivisions (c) and (d) shall not be applicable in air pollution control districts formed between January 1, 1964, and the effective date of the amendment of this section at the 1965 Regular Session of the Legislature.

(g) On and after December 1, 1967, every 1968 or later year model passenger vehicle, except motorcycles, subject to registration and first sold and registered in this state shall be equipped with a certified device or devices to control emission of pollutants from the crankcase and exhaust. Notwithstanding any other

provision of this section or Section 24386, the Motor Vehicle Pollution Control Board may only grant an exemption for not to exceed 1 percent of a manufacturer's passenger vehicle sales in California in the preceding model year.

(h) On and after December 1, 1966, every 1967 or later year model commercial motor vehicle under 5,001 pounds unladen, subject to registration and first sold and registered in this state shall be equipped with a certified device or devices to control emission of pollutants from the crankcase and exhaust.

(i) On and after December 1, 1968, every 1969 or later year model truck, truck-tractor, or bus, except those which are diesel-powered, subject to registration and first sold and registered in this state shall be equipped with a certified device or devices to control emission of pollutants from the crankcase and exhaust. Notwithstanding any other provision of this section or Section 24386, the Motor Vehicle Pollution Control Board may only grant an exemption for not to exceed 1 percent of a manufacturer's truck, truck-tractor and bus sales in California in the preceding model year.

(j) Motor vehicles found by the board to meet established state standards and board criteria without additional equipment are exempt from the provisions of this section.

(k) The provisions of subdivisions (c) and (d) of this section shall not be applicable to motor vehicles registered to an owner whose residence is in any county in which an air pollution control district may function and exercise its powers if (1) prior to the effective date of this section, the board of supervisors of the county has, pursuant to Section 24394, found that the equipment of motor vehicles with devices to control the emission of pollutants is unnecessary for the preservation of air quality in that county, and (2) no air pollution control district created pursuant to Chapter 2 (commencing with Section 24198) of Division 20 has ever been authorized to function and exercise its powers in any county adjacent to such county; nor shall such provisions be applicable to motor vehicles registered to an owner whose residence is in any county adjacent to such a county, which adjacent county is included within the boundaries of an air pollution control district created by special law to include the area of two or more counties, and in which county such air pollution control district created by special law may transact business and exercise its powers.

(l) The provisions of subivisions (c) and (d) of this section shall not be applicable to motor vehicles registered to an owner whose residence is in an area, designated pursuant to this subdivision, of any county having an area in excess of 7,000 square miles in which an air pollution control district consisting of a single county may function and exercise its powers and within 60 days after the effective date of this section the board of supervisors of such county has classified the county into two areas because of substantial geographic and climatic differences between the two areas, and within 60 days after the effective date of this section the board of supervisors of the county has found that within one of such areas, designated by the board, the equipment of motor vehicles with devices to control the emission of pollutants is unnecessary for the preservation of air quality within that area.

24391. No new motor vehicle required pursuant to this chapter to be equipped with a certified device to control the emissions of pollutants from the crankcase or exhaust shall be sold in this state unless the manufacturer thereof has filed a certificate with the board within the preceding 12 months stating that all new motor vehicles of that make, model and year will be equipped at the factory with certified devices as required by this chapter.

24395. No person shall sell, display, advertise, or represent as a certified device any device which, in fact, is not a certified device. No person shall install or sell for installation upon any motor vehicle any motor vehicle pollution control device which has not been certified by the Motor Vehicle Pollution Control Board.

24396. Any violation of this article is a misdemeanor.

Article 4. Authorized motor vehicle pollution control testing laboratories

24397. The Motor Vehicle Pollution Control Board may designate such laboratories as it finds are qualified and equipped to analyze and determine, on the basis of the standards established by the board, devices which are so designed and equipped to meet the standards set by the state department under Section 426.5 and the criteria established by the Motor Vehicle Pollution Control Board.

24398. The Motor Vehicle Pollution Control Board may contract for the use of, or the performance of the tests or other services by, a laboratory or laboratories operated by any public or private agency, within or without the State.

All testing of devices by the board for purposes of certification shall be performed pursuant to such contracts.

24399. All devices tested for purposes of certification shall be tested by a procedure which includes tests of the device to measure its ability to control the emission of pollutants while a vehicle is operating at full performance.

State standards

426.1 *Health and safety code.*—The State Department of Public Health shall, before February 1, 1960, develop and publish standards for the quality of the air of this State. The standards shall be so developed as to reflect the relationship between the intensity and composition of air pollution and the health, illness, including irritation to the senses, and death of human beings, as well as damage to vegetation and interference with visibility.

The standards shall be developed after the department has held public hearings and afforded an opportunity for all interested persons to appear and file statements or be heard. The department shall publish such notice of the hearings as it determines to be reasonably necessary.

The department, after notice and hearing, my revise the standards, and shall publish the revised standards, from time to time.

426.3 The State Department of Public Health shall by February 1, 1967, define and publish criteria concerning the levels, duration, and frequency of occurrence of contaminants in the atmosphere, including those contaminants emitted from motor vehicles, which, if occurring in the atmosphere of any area in this state, will pose a substantial threat to the public health, including irritation to the senses or will interfere with visibility or damage vegetation.

The criteria shall be developed after the department has held public hearings and afforded an opportunity for all interested persons to appear and file statements or be heard. The department shall publish such notice of the hearings as it determines to be reasonably necessary.

The department after notice and hearing may revise the criteria and shall publish the revised criteria, from time to time.

426.5 It shall be the duty of the State Director of Public Health to determine by February 1, 1960, the maximum allowable standards of emissions of exhaust contaminants from motor vehicles which are compatible with the preservation of the public health including the prevention of irritation to the senses, interference with visibility and damage to vegetation.

The standards shall be developed after the department has held public hearings and afforded an opportunity for all interested persons to appear and file statements or be heard. The department shall publish such notice of the hearings as it determines to be reasonably necessary.

The department after notice and hearing may revise the standards, and shall publish the revised standards, from time to time. In revising the standards the department shall, after February 1, 1960, take into account all emissions from motor vehicles rather than exhaust emissions only.

Whenever the department revises the standards it shall submit a copy of such revised standards to the Legislature if the Legislature is in session, or to the Senate Fact Finding Committee on Transportation and Public Utilities and the Assembly Interim Committee on Transportation and Commerce if the Legislature is not in session, and such revised standards shall not become effective until the 31st day after such submission.

Vehicle code: Sections relating to motor vehicle pollution control

2813. Every driver of a commercial vehicle shall stop and submit the vehicle to an inspection of the size, weight, equipment, and smoke emissions of the vehicle at any location where members of the California Highway Patrol are conducting tests and inspections of commercial vehicles and when signs are displayed requiring such stop.

2814. *Roadside inspection.*—Every driver of a passenger vehicle shall stop and submit the vehicle to an inspection of the mechanical condition and equipment of the vehicle at any location where members of the California Highway Patrol are conducting tests and inspections of passenger vehicles and when signs are displayed requiring such stop.

The Commissioner of the California Highway Patrol may make and enforce regulations with respect to the issuance of stickers or other devices to be displayed upon passenger vehicles as evidence that the vehicles have been inspected and

have been found to be in safe mechanical condition and equipped as required by this code and equipped with certified motor vehicle pollution control devices as required by Section 24390 of the Health and Safety Code which are correctly installed and in operating condition. Any sticker so issued shall be placed on the windshield within a five-inch square in the extreme lower left corner thereof with respect to the driver's position.

If, upon such an inspection of a passenger vehicle, it is found to be in unsafe mechanical condition or not equipped as required by this code and the provisions of Section 24390 of the Health and Safety Code, the provisions of Article 2 (commencing with Section 40150) of Chapter 1 of Division 17 of this code shall apply.

4000. *Registration requirements.*—No person shall drive, move, or leave standing any motor vehicle, trailer, semitrailer, pole or pipe dolly, or auxiliary dolly upon a highway unless it is registered and the appropriate fees have been paid under this code.

No person shall drive, move, or leave standing any motor vehicle upon a highway which has been registered in violation of Chapter 3 (commencing at Section 24378) of Division 20 of the Health and Safety Code.

4000.1 (a) On and after December 1, 1965, the department shall require upon transfer of ownership and registration of any motor vehicle subject to Section 24390 of the Health and Safety Code, a valid certificate of compliance from a licensed motor vehicle pollution control device installation and inspection station indicating that such vehicle is properly equipped with a certified device or devices which are in proper operating condition and which are in compliance with the provisions of Chapter 3 (commencing with Section 24378) of Division 20 of said code.

(b) The Motor Vehicle Pollution Control Board established under Chapter 3 (commencing with Section 24378) of Division 20 of the Health and Safety Code may exempt designated classifications of motor vehicles from the provisions of subdivision (a) as they deem necessary, and shall notify the department of such action; provided, however, that no exemption shall be granted to those vehicles subject to the provisions of subdivision (g) or (i) of Section 24390 of the Health and Safety Code, except as provided therein.

4750. The department shall refuse registration or renewal or transfer of registration upon any of the following grounds:

(a) That the application contains any false or fraudulent statement.

(b) That the required fee has not been paid.

(c) That the registration or renewal or transfer of registration is prohibited by the requirements of Chapter 3 (commencing at Section 24378) of Division 20 of the Health and Safety Code.

9250. A registration fee of eight dollars ($8) shall be paid to the department for the registration of every vehicle of a type subject to registration, except as are expressly exempted under this code from the payment of registration fees. and except those referred to in Section 9253.

During the 1966 calendar year, the registration fee imposed by this section shall be nine dollars ($9) for each such vehicle; during the 1967 calendar year, the registration fee imposed by the section shall be ten dollars ($10) for each such vehicle; and commencing with the 1968 calendar year and each calendar year thereafter, the registration fee imposed by this section shall be eleven dollars ($11) for each such vehicle.

9253. A registration fee of nine dollars ($9) shall be paid to the department for the registration of every station wagon, which is subject to registration.

During the 1966 calendar year, the registration fee imposed by this section shall be ten dollars ($10) for each such vehicle; during the 1967 calendar year, the registration fee imposed by this section shall be eleven dollars ($11) for each such vehicle; and commencing with the 1968 calendar year and each calendar year thereafter, the registration fee imposed by this section shall be twelve dollars ($12) for each such vehicle.

24007. (a) No dealer shall sell a new or used motor vehicle which is not in compliance with the provisions of this code and department regulations adopted pursuant to this code unless the vehicle is sold to another dealer or for the purpose of being wrecked or dismantled.

(b) No dealer shall sell a new or used motor vehicle subject to the provisions of Section 24390 of the Health and Safety Code which is not in compliance with the provisions of Chapter 3 (commencing with Section 24378) of Division 20 of said code and the roles and regulations of the Motor Vehicle Pollution Control Board, unless the vehicle is sold to another dealer or for the purpose of being wrecked or dismantled. The dealer shall, with each application for transfer of registra-

tion of every 1955 or later year model motor vehicle subject to Section 24390 of the Health and Safety Code, transmit to the Department of Motor Vehicles a valid certificate of compliance from a licensed motor vehicle pollution control device installation and inspection station indicating that such vehicle is properly equipped with a certified device or devices which are in proper operating condition and which are in compliance with the provisions of Chapter 3 (commencing with Section 24378) of Division 20 of said code.

26708. (a) No person shall drive any motor vehicle with any sign, poster, card, sticker, or other nontransparent material upon the front windshield, side wings, side or rear windows of the vehicle, except that signs, posters, cards, stickers, or other materials may be placed on the windshield within a seven-inch square in the lower corner farthest removed from the driver's position or upon the side windows of the vehicle to the rear of the driver and so placed that the materials will not obstruct the driver's clear view of approaching traffic, and except as provided for by Section 2814 of this code.

(b) No person shall drive any motor vehicle upon a highway with any object or material so placed in or upon the vehicle as to obstruct or reduce the driver's clear view through the windshield, except required or permitted equipment of the vehicle and adjustable nontransparent sun visors which are not attached to the glass.

(c) This section does not apply to direction, destination, or termini signs upon a passenger common carrier motor vehicle.

27156. No person shall operate or leave standing upon any highway any motor vehicle which is required to be equipped with a certified motor vehicle pollution control device under Chapter 3 (commencing with Section 24378) of Division 20 of the Health and Safety Code unless the motor vehicle is equipped with a certified motor vehicle pollution control device which is correctly installed and in operating condition. No person shall disconnect, modify, or alter any such device in a manner which will decrease its efficiency or effectiveness in the control of air pollution.

40004. It is unlawful and constitutes a misdemeanor for any person knowingly to make any false or fraudulent statement on an application for registration or renewal or transfer of registration of a motor vehicle.

The sum of five hundred thousand dollars ($500,000) is appropriated from the General Fund in augmentation of Item 195, Budget Act of 1960, for support of the State Department of Health in carrying out the provisions of Chapter 3 (commencing at Section 24378), Division 20 of the Health and Safety Code.

If any provision of this act or the application thereof to any person or circumstances is held invalid, such invalidity shall not affect other provisions or applications of the act which can be given effect without the invalid provision or application, and to this end the provisions of this act are serverable.

CHAPTER 7. MOTOR VEHICLE POLLUTION CONTROL DEVICE INSTALLATION AND INSPECTION STATIONS

28500. As used in this chapter:

(a) "Motor vehicle pollution control device" and "certified device" shall be construed as defined in Section 24379 of the Health and Safety Code.

(b) "Station" means a motor vehicle pollution control device installation and inspection station.

(c) "Licensed Station" means a station licensed by the department pursuant to this chapter.

(d) "Licensed installer" means a person licensed by the department for installing, repairing, inspecting, or recharging motor vehicle pollution control devices in licensed stations.

28501. No person shall operate a station unless a license therefor has first been issued by the department.

28502. (a) The department shall license stations and shall designate, furnish instructions to, develop regulations for, and supervise licensed stations for installing, repairing, inspecting, or recharging motor vehicle pollution control devices in conformity with the provisions of Chapter 3 (commencing with Section 24378) of Chapter 20 of the Health and Safety Code and the rules and regulations of the department. The department shall establish standards for the qualifcations, including training, of licensed installers as a condition to designating and licensing the station as a licensed station.

An owner of a fleet of three or more vehicles may be licensed by the department as a licensed station, provided such owner complies with the regulations of the department.

(b) The department shall license, furnish instruction to, develop regulations for, and supervise licensed installers as a condition for installing, repairing, inspecting, or recharging motor vehicle pollution control devices in licensed stations.

28503. The department may refuse to issue a license to an applicant who has made application for a station or an installer license when it determines:

(a) The applicant was previously the holder of a license issued under this chapter, which license was revoked for cause and never reissued by the department, or which license was suspended for cause and the terms of the suspension have not been fulfilled; or

(b) The information contained in the application is incorrect.

28504. (a) The department after notice and hearing may suspend, revoke, or refuse to renew the license issued to a licensed station upon determining that the licensee is not lawfully entitled thereto, has used a false or fictitious name, knowingly made any false statements or concealed any material fact in any application for such license, has violated one or more of the regulations developed by the department under this chapter, or has failed to properly perform the business of a licensed station.

(b) The department after notice and hearing may suspend, revoke, or refuse to renew the license issued to a licensed installer upon determining that the licensee is not lawfully entitled thereto, has used a false or fictitious name, knowingly made any false statements or concealed any material fact in any application for such license, has violated one or more of the regulations developed by the department under this chapter, or has failed to properly carry out the duties of a licensed installer.

(c) The department shall not reinstate a revoked license within less than one year from the date of revocation.

28505. Every hearing provided for in this chapter shall be pursuant to the provisions of Chapter 5 (commencing with Section 11500) of Part 1 of Division 3 of Title 2 of the Government Code.

28506. Any person may install a motor vehicle pollution control device; however, no person who is not a licensed installer shall install such a device for compensation. No such device shall be deemed to meet the requirements of this code or of Chapter 3 (commencing with Section 24378) of Division 20 of the Health and Safety Code and the rules and regulations of the Motor Vehicle Pollution Control Board unless it has been inspected by a licensed installer in a licensed station and a certificate of compliance has been issued by such licensed station.

28508. Whenever a licensed installer in a licensed station, in conformity with the instructions of the department, installs, inspects, repairs, or recharges a motor vehicle pollution control device, and determines that the device conforms with the requirements of Chapter 3 (commencing with Section 24378) of Division 20 of the Health and Safety Code, and the rules and regulations of the Motor Vehicle Pollution Control Board, a certificate of compliance shall be issued to the owner or driver of the vehicle. The department, for a fee of ten cents ($0.10), shall furnish to the licensed station the certificate of compliance to be issued.

The certificate of compliance shall contain provisions for the date of issuance; the make and registration number of the vehicle; the name of the owner of the vehicle; and the official designation of the station; and if the device involved was approved by the Motor Vehicle Pollution Control Board by the issuance of a certificate of approval requiring the obtaining of an annual certificate of compliance, as authorized by Section 24386.2 of the Health and Safety Code, a statement that the certificate of compliance shall be valid only through the last day of the 12th month from the date of issuance.

The certificate of compliance shall be signed by a licensed installer who has installed, inspected, repaired, or recharged the motor vehicle pollution control device.

28509. The following fees shall be paid to the department for a motor vehicle pollution control device installation and inspection station license:

(a) From the original application for a license: $10.00.

(b) For the annual renewal of the license: $5.00.

28510. (a) Every license issued pursuant to this chapter shall expire at midnight on the 31st day of December of each year and a new license may be obtained by the person to whom any such license was issued as provided in subdivision (b).

(b) Every application for the renewal of a license shall be made by the person to whom issued between November 1st and midnight of November 30th preceding the expiration date and shall be made by presenting the application form provided by the department and payment of the full annual renewal fee for such license.

28511. It is unlawful for any person, other than a licensed station, to issue a certificate of compliance required by this chapter.

40001. (a) It is unlawful for the owner, or any other person, employing or otherwise directing the driver of any vehicle to cause the operation of the vehicle upon a highway in any manner contrary to law.

(b) It is unlawful for an owner knowingly to permit the operation of any vehicle:

(1) Which is not registered or for which any fee has not been paid under this code.

(2) Which is not equipped as required in this code.

(3) Which does not comply with the size, weight, or load provisions of this code.

(4) Which does not comply with the regulations promulgated pursuant to this code.

(5) Which is not in compliance with the provisions of Chapter 3 (commencing with Section 24378) of Division 20 of the Health and Safety Code and the rules and regulations of the Motor Vehicle Pollution Control Board.

42271.5 The Legislature hereby declares its intent that revenue received from additional fees imposed pursuant to Sections 9250 and 9253 of this code by the 1965 act amending these sections shall be appropriated for the purpose of doubling the uniformed strength of the California Highway Patrol by December 31, 1968.

In so doing the Legislature declares its desire to increase the number of onview Highway Patrol enforcement units as a greater deterrent to potential law violators, and to place additional emphasis on proper maintenance of vehicles, thus resulting in a balanced traffic safety program which deals with driver, vehicle and use of the highway system.

Notwithstanding the provisions of Section 24396 of the Health and Safety Code and Section 40000 of the Vehicle Code, and notwithstanding the repeal of Section 24393.4 of the Health and Safety Code and Section 27156.5 of the Vehicle Code by this act, the failure, prior to the effective date of this act, of any person to have a certified motor vehicle pollution control device for the control of emission of pollutants from the crankcase installed upon a used passenger vehicle, as required by Section 24393 of the Health and Safety Code as it read prior to the effective date of this act, shall not constitute a crime; and no prosecution of such person for a violation of Section 24393 of the Health and Safety Code or Section 27156 of the Vehicle Code on account of such failure occurring prior to the effective date of this act shall be commenced or continued.

This act is an urgency measure necessary for the immediate preservation of the public peace, health or safety within the meaning of Article IV of the Constitution and shall go into immediate effect.

Labor code: Sections relating to air pollution control

6418. It shall be the duty of the division to determine by February 1, 1967, the maximum allowable standards of emissions of contaminants from portable and from mobile internal combustion engines used inside factories, manufacturing plants, warehouses, buildings and other enclosed structures, which standards are compatible with the safety of employees.

The standards shall be developed after the division has held public hearings and afforded an opportunity for all interested persons to appear and file statements or be heard. The division shall publish such notice of the hearings as it determines to be reasonably necessary.

The division after notice and hearing may revise the standards, and shall publish the revised standards, from time to time.

6419. All portable and all mobile internal combustion engines that are used inside factories, manufacturing plants, warehouses, buildings and other enclosed structures shall be equipped with a certified exhaust purifier device after the certification of such a device by the Motor Vehicle Pollution Control Board.

The Division of Industrial Safety shall be responsible for the enforcement of the provisions of this section.

6420. Sections 6418 and 6419 shall apply to all portable and all mobile internal combustion engines used inside factories, manufacturing plants, warehouses, buildings and other enclosed structures unless the operation of such an engine used inside a particular factory, plant, warehouse, building or enclosed structure does not result in harmful exposure to concentrations of dangerous gases or fumes in excess of maximum acceptable concentrations as determined by the division.

Amended or added, 1966 Special Session—effective October 6, 1966. Health & Safety Code Sections 426.3, 24391, 24386(4), 24386.2. Labor Code 6418, 6419, 6420. Vehicle Code 2813, 24007, 28506.

July 18, 1966.

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RESOLUTION No. 66-23

Whereas the Motor Vehicle Pollution Control Board is charged by the People of the State of California to control emissions from motor vehicles, and this effort has resulted in the certification of exhaust emission and crankcase control devices meeting established State standards for maximum allowable emissions from motor vehicles operated on the roads of California; and

Whereas the Federal Government recognized the importance of these control systems and required them on all vehicles nationwide, commencing with the 1968 model vehicles; and

Whereas the Federal requirements specify substantially those emission standards adopted by the California State Department of Public Health for motor vehicles; and

Whereas the California State Department of Public Health has established emission standards for 1970 model vehicles which they have determined are essential for the protection of the health and safety of the people of this State; and

Whereas these standards are established at 180 parts per million hydrocarbons and 1.0 percent carbon monoxide, and are based upon the absolute necessity of reducing emissions from motor vehicles as effectively and as rapidly as possible; and

Whereas emission control standards have been established for diesel emission control, oxides of nitrogen control, and evaporation control for motor vehicles; Now, therefore, be it

Resolved, That it is the established policy of this Board that:

(1) The automobile industry worldwide is hereby informed that the State of California shall require compliance with these standards, regardless of the emission requirements established by the Federal Government.

(2) This Board shall continue its leadership, interest, and enforcement of strong air pollution laws, rules and regulations, to achieve the accomplishment of these objectives, and shall do everything within our technical and administrative means to secure compliance with these standards.

(3) This Board recognizes that motor vehicles, in order to operate on the streets and highways of the great State of California, must not destroy our air as a natural resource.

(4) In recognition of the needs of this State, this Board shall maintain a constant vigilance to protect our air quality and demand stricter control and regulations in the future, as deemed necessary by the State Department of Public Health.

Mr. GRANT. It has always been the policy of the motor vehicle pollution control board to keep you well informed as to the activities and progress which we have been able to accomplish toward control of emissions from motor vehicles.

It is my pleasure to indicate to you today that our accomplishments have been significant; that our control programs are eliminating large amounts of raw gasoline from the atmosphere; and that the future results from our continued efforts, we feel confident, will ultimately eliminate the motor vehicle as a source of pollution.

The chart (p. 560) which indicates to you the gains we have made. If no pollution control devices had been installed on motor vehicles this chart would have continued to soar. As you can see, there is approximately 2 million gallons of gasoline going out over the air in Los Angeles. When we put our crankcase control devices on the vehicles, we saw a decrease, but not a reduction. This is the same portion of the program or the point in the program that you are on on a national level now because of the crankcase approved devices going on all vehicles nationwide starting with the 1963 model.

With the crankcase device you have a decrease in the amount of pollution into the air, but not a reduction.

However, I would like to emphasize when you calculate out the fact that approximately 10 percent of the total fuel delivered to a motor vehicle—as an example, Mr. Chairman, if you were to buy 10 gallons of gasoline at the station and pay your money for 10 gallons, 1 of those gallons on the uncontrolled vehicle goes out into the atmosphere.

This 2-million figure is based on approximately 20 million gallons being sold each day in Los Angeles. The American Petroleum Institute, and I feel this is important to you gentlemen, on a national level indicated there were in excess of 70 billion gallons of gasoline sold in the United States in calendar year 1965.

Take 10 percent of that, and it comes to about 7 billion. Now, to get a more realistic figure, we cut this down to 1 hour's time. Every hour of the day, 24 hours a day, on a national approach there is over 800,000 gallons of gasoline going off into the atmosphere. Now, that is a staggering amount of pollution.

Gentlemen, I must emphasize I am glad to see you taking the interest you are in this problem from the nationwide approach. In some of this material I am going to submit to you there is an information type of report which indicates what the 1966 exhaust control device on all California vehicles resulted in.

We see there a significant reduction, and we feel confident the systems are working satisfactorily, and we can look into 1967 to see even better devices.

The efforts of the motor vehicle pollution control board, as a result of the strong support received from this committee, the Governor's office, the Senate Transportation Committee, have allowed us to cooperatively demand from the American automobile industry controls that actually do function effectively and conserve our natural resource, air.

Now, I emphasize cooperatively, because we do not work in a vacuum. In all our committee efforts and board's efforts, although we don't always do as they think is quite proper, we certainly recommend the importance of cooperating with the automobile industry because, in fact, they are the ones that have to put the devices on the automobile.

Mr. BELL. May I interrupt to see if Mr. Grant has any copies of the statement he might pass to the committee?

Mr. GRANT. Yes, I do. There is one in each of these envelopes, with some descriptive materials on the devices themselves. This is the material for the committee, which I am sorry, I only have one copy. I can give you more copies, but this descriptive material on this has my statement, and also a copy of the speech I referred to at the API.

We know that our efforts have caused the manufacturers of motor vehicles to not only install control equipment, but to be more concerned about quality control in their production. They have upgraded the quality of carburetors, ignition systems, and many other components of the engines. We also know that throughout the State of California, predelivery service performed by dealers prior to delivery of the vehicle to the purchaser has greatly improved. The ultimate result is that the motorist in California is purchasing a better vehicle.

We know that our efforts to date with over 6 million vehicles equipped with crankcase control devices, and with approximately 800,000 1966 model vehicles equipped with exhaust control equipment, keep from our skies nearly 400,000 gallons of gasoline each day. A unique factor involved in this is that a large percentage of this gasoline is being used by the motorist at a considerable saving to him. As an example, we know that a properly installed crankcase emission control system results in about a 3-percent increase in mileage, since raw gasoline which was going out into the air is now kept in the engine and used as fuel.

There is also a report made to the Board by John Maga, of the State department of public health, bureau of air sanitation, which indicates in figure 1 that the results of our efforts to date have caused about a 30-percent reduction in emissions into the atmosphere of contaminants which would have been present if we had not taken action commencing in 1960.

These have been on all new vehicles, and we have a used vehicle program which requires them to be installed on used vehicles at the time of change of ownership back to 1955.

Of particular importance are the statistics on page 4 which indicate that there are still about 1,250,000 vehicles which still need to be equipped, and presumably a sizable percentage of these will be subject to our regulations because of sale and transfer of ownership in the future.

We have also made a real effort to control emissions from diesel vehicles. The obnoxious black smoke which, under some conditions is emitted from diesel vehicles, has been reduced on the highways of California due to legislation passed at the last session, and the cooperative efforts made by ourselves and the California Trucking Association, which organization has made a diligent effort to secure cooperative interest on the part of its own members to achieve control of their diesel vehicles.

We now have standards for odor and visible smoke, and possibly in the future devices will be developed that may be applied to diesel vehicles. In the meantime, however, due to the complexities of the control of these emissions, we feel that strong on-the-road enforcement, plus cooperative interest, have achieved and will achieve a great deal.

As Dr. Haagen-Smit indicated, there has been considerable interest shown in the control of oxides of nitrogen. In section 5 of the submitted material, we have title 13 of the California Administrative Code. On page 5 are the criteria which have now been finalized. We are prepared to evaluate any device to control oxides of nitrogen. None as yet has been presented to the board.

In section 6 of the pamphlet, you have for your files a copy of all the laws relating to motor vehicle emission control in the health and safety code. This includes those sections from assembly bills 72, 73, 74, 75, and 98, passed at the last session.

I hope, Mr. Chairman, that this has defined the present status of the board. I would like to indicate additional areas of concern. The board, at its last meeting, took a strong position in support of the need for continued increased effort to secure more and better control of emissions from motor vehicles. As the charts indicate, we cannot

achieve 1940 air unless this action is taken. The automobile industry and the Federal Government have been made aware of the absolute necessity of accomplishing the 1970 standards recommended by the State department of public health.

The present standards, Mr. Chairman and members of the committee, as to hydrocarbons are 275 parts per million. This is also the standard adopted by the Federal Government with some modification for the small foreign vehicles. We level out here in the future to 180, and are still kicking out in our atmosphere in excess of 8 million gallons a day. We have got to get down considerably lower to get 1940 air.

This is why the board has taken this position, and to graphically illustrate it here in order to achieve this in 1970, we have to establish the 180 parts per million, and in the 1970's conceivably go below this down to 100, in order to achieve the quality of air necessary.

The 180 parts per million is the one established and recommended by California. I made a statement to the California Assembly Transportation Committee indicating we felt strongly this was necessary to make it mandatory, and I would feel, if I may express an opinion, that there is considerable interest in this approach.

We strongly support the need for conservation of our air resource, which necessitates the creation of a statewide agency which will function as a coordinating, and if necessary enforcing agency, to control emissions from all sources.

This, Mr. Chairman, reflects, I believe, some of the concern Mr. Bell indicated as to the tying together of the various actions of the various local, State, county, and city organizations. We feel this is the central approach which should be adopted by California, bringing together the same concept of control. As an example, in the motor vehicle area, making it statewide.

I certainly would not minimize the efforts the districts are making now, but there are many areas of the State where there is total pollution going on unhampered.

We are convinced that the people of California, the legislature, and the administration no longer can permit indiscriminate, uncontrolled, illegal contamination of the air we breathe.

Present standards established by the State department of public health are only recommended for 1970 under present law. They would not become mandatory until two or more devices have been developed to meet the requirements. I feel that as the charts indicate, it is essential that we make these 1970 standards mandatory and give notice to industry that their vehicles shall not exceed these basic requirements. I feel that it is within the ability of the industry to control their vehicles to this degree, and that certainly a timely notice to them would give them sufficient time to comply and deliver to the California motorists vehicles that do not emit excessive pollutants into our atmosphere.

I may add this was taken at the last board meeting, and that the resolution which is in the submitted material, was recommended by the executive committee to the board.

We in California cannot take a chance that the Federal Government will answer our needs. We recognize that your Federal efforts will result in a strong vehicle emission control program nationwide. How-

ever, at the same time we know that our control efforts here must continue at the strong leadership level we have established.

Essentially, all present controls on stationary sources in America are patterned after the Los Angeles County Air Pollution Control Districts' program.

All present controls on vehicles in the world are patterned after our State motor vehicle pollution control board's actions and leadership.

You and your colleagues in Washington must recognize the importance of this and not allow Federal entry into this area to diminish its effectiveness. Local, State, and Federal efforts to collectively work together to accomplish our needs have in the past and should in the future result in significant program gains.

In conclusion, I would like to indicate to you again that the board is confident that considerable pollution is being kept from the air, and that this is an important factor in the fact that there have been fewer incidents of air pollution; and that with each day that passes, there will be more and more vehicles on the road which are controlled. I would like to emphasize, however, that we are a long way from our goal. There is still serious air pollution, and if the weather is adverse we shall have smog alerts. We shall put forth continued effort so as to assure the people of California that eventually the air of California will be fit to breathe.

Mr. BROWN. Thank you, Mr. Grant.

Mr. Bell?

Mr. BELL. Thank you, Mr. Grant. Let me welcome you to the committee and commend you for your very excellent statement.

Mr. GRANT. Thank you, Mr. Bell.

Mr. BELL. Has there been a difference in acceptance of the automobile devices between Los Angeles basin residents and those in smog-free areas?

Mr. GRANT. It is a twofold question, Mr. Bell. It is a yes and no.

As to the new devices going on new vehicles, there has been very little concern. They are built into the vehicles and are covered by the manufacturer's warranty. There are next to no problems. With these there has been citizen acceptance.

As to the used vehicle application, I would have to say there has been a hazy area. Many of the people in the initial portion of the program were faced with the absolute need of putting a device on within a schedule during the year in 1964 and 1965, and this caused concern. There were motorists who felt it was unfair.

We do have devices and there were many problems, as I am sure you are aware of, in relation to the emission control program.

However, with the legislation being changed in 1965 so that only at the time of transfer of ownership was it necessary to put a device on the vehicle, and only in those metropolitan counties, such as Los Angeles and other areas, there has been very little problem. We have almost reduced complaints in the motorists concerned down next to nil.

This is not to say there is not some concern. Still you hear that some of the mechanics don't like them. But properly installed devices will not give you trouble, and we have yet to find a motorist who has a device on a vehicle, unless it is a total wreck, where the device gives him any problem.

Mr. BELL. I was going to ask you what is known about the inspection, maintenance, and cost of these devices.

Mr. Grant. I assume you are referring to the exhaust control system on the 1966 vehicles?

Mr. BELL. Yes.

Mr. GRANT. As part of our certification of the original device, we made it contingent upon a regular annual inspection of some type, and this was not accepted by the legislature, and they directed us to change our requirements for the device so they would be effective essentially for the life of the vehicle.

We did respond to this, and now the 1967 devices, which are essentially the same as the 1966 devices, are good for the life of the vehicle.

There is, however, always this need in maintaining any vehicle for periodic service. Then the question comes in, what is periodic service? In our evaluation and testing of the device, periodic service meant that at 25,000 miles, from zero to 25,000 miles you were allowed to give it a minor tuneup, and aside from that no other service. This was projecting it out to 50,000 miles.

You had one tuneup at 25,000, and most motorists will recognize the need for reasonable mechanical service. Every manufacturer recommends that every 12,000 miles, you should have this minor tuneup service on the vehicle.

So these systems we have evaluated will last for the life of the vehicle with a minor tuneup at every 25,000 miles through the life of the vehicle.

We have not considered the necessity of annual inspection at this phase in the game. We were told we could not do that. However, there is still the importance of the fact that we are continuing surveillance of these vehicles. We are constantly bringing in representative vehicles and finding out how they are working in the hands of motorists.

It may prove that in the future that the service the motorist is giving his vehicle is not sufficient to keep the emissions down to where it should be, and it may be necessary in the future, we will need more data to take a position on this, that annual inspection is required.

Now, as to the service that is actually necessary, it is next to nothing. These systems are an integral part of the engine, and they require very little extra maintenance to make sure that the fan belts are working on the air pump and are properly installed.

Mr. BELL. Mr. Grant, perhaps you would like to comment on the statement by the last witness. What part do you feel the Federal Government should play in a program of this kind, particularly in the automotive field?

Mr. GRANT. I feel that the Federal Government has played a very significant part to the extent they have gone already.

Mr. BELL. I should have said, if any.

Mr. GRANT. I am convinced they have. I couldn't very well say anything else, because they have almost carte blanche adopted our procedures and regulations for devices, and are going to evaluate them for the 1968 vehicles. They are good systems. They will reduce total emissions into the atmosphere.

Being air pollution oriented, I would say to eliminate air pollution in any portion of the country is a noble endeavor, and the preventive

maintenance to prevent that kind of problem from arising in other parts of the country.

Mr. BELL. In other words, you think there has to be some uniformity? My next question would involve that. Should there be some type of uniformity?

Mr. GRANT. Yes, I do. There is your uniformity built into it at the present time. You have the nationwide application, the one standard for the car device being approved. However, at the same time, as I indicated in my statement, I would feel it would be very ill-advised action for the Federal Government to preempt the activities of those areas that have done so much to control emission.

At the same time I seriously question—I know the Federal people, and I work with them, and I say this with great respect for them, but I question whether or not they will be able on a national level to demand the devices or systems we are going to have to have in California.

We were 2 years ahead of the national program on crankcase devices. We are now 2 years ahead on the exhaust emission control.

I foresee that by 1970, and I might indicate the industry is pretty well in line with and recognizes that California has to go a little further than we are now, and I feel confident we will have 180 parts per million devices in California.

It would take a great deal of not only personal but unified effort on the part of you people in Congress to recognize the need for the strict control, but I honestly and seriously question this on the national level, whether it would be successful.

Mr. BELL. I agree with you. However, you do believe that further research and effort should be made on the part of all?

Mr. GRANT. Very definitely.

Mr. BELL. Perhaps the Federal Government can play some part in that.

Mr. GRANT. Yes, very much so. The Federal Government has shown considerable leadership in this particular area. They have been active many years now in supplying assistance not only through their own facilities, but in funds to other agencies to assist them in their programs.

Mr. BELL. Thank you.

Mr. BROWN. Mr. Grant, there are a number of other questions we will not be able to ask, because of the shortness of time this morning. We have an additional witness. I am particularly interested in the research needs, if we are going to have mandatory standards in 1970 of 180 parts per million, for example. I also wonder whether the automobile industry is going to be able to meet this deadline.

Mr. GRANT. I would like, Mr. Chairman, to reiterate the statement Mr. Fuller indicated, and that I initially said, we are delighted to have the opportunity, shall I say, to spread the gospel and give you and a committee such as yours whatever information we have available.

Mr. BROWN. We are grateful for your appearance here this morning. It has been extremely valuable, and we thank you for it.

Mr. GRANT. Thank you.

Mr. BROWN. Our next witness is Mr. W. L. Rogers, of Aerojet-General Corp.

As he comes forward, and before he makes his statement, I would like to acknowledge the presence of a group from the Stamp Out Smog organization, headed by Mrs. Slade, who is here this morning.

Mrs. Slade. At the end of the hearing I would like to make a statement.

Mr. Brown. We will try to give you that opportunity.

Mr. Rogers.

STATEMENT OF W. L. ROGERS, VICE PRESIDENT AND GENERAL MANAGER, VON KARMAN CENTER, AEROJET-GENERAL CORP.

Mr. Rogers. Congressman Brown and Congressman Bell, I thank you on behalf of Aerojet-General Corp. for this opportunity to testify this morning.

I would like to request your permission to forward a statement to the committee for the record which will amplify the remarks I make this morning.

(This statement may be found on p. 598.)

Mr. Brown. Without objection, that will be done.

Mr. Rogers. Aerojet-General Corp. has been pleased to serve the U.S. Government, which is our principal customer for almost 25 years in the field of defense, and in more recent years space as well as the Department of Interior Office of Saline Water.

Perhaps our greatest contributions in these years has been in the development of liquid and solid rocket engines for various missiles, but today the company is making significant contributions in many other areas. In the Von Karman Center in Azusa, the plant I represent is engaged in producing the Mark 46 torpedo for the Navy, the development and building of payloads for the Air Force, developing the SNAP–8 for NASA, working in life sciences technology for the Air Force, and doing research and development for the Office of Saline Water in reverse osmosis, a method of desalting sea water and cleaning polluted water.

I mention these programs to give the background and capabilities that are represented by our staff of 4,400, of which some 1,700 engineers and scientists represent a broad range of specialties and capabilities.

We are now turning our attention toward the problem of pollution. I would like at the outset to say that my comments are not aimed directly at the Los Angeles County air pollution problem, because you have heard from the real experts here this morning in the preceding witnesses. My comments will, I hope, pertain to the overall work of the committee in assessing the adequacy of the technology.

Mr. Brown. We are particularly grateful for that emphasis.

Mr. Rogers. Now as to Aerojet's work which is pertinent to the interest of this committee. When Governor Brown initiated efforts to investigate the applicability of aerospace systems approach to special problems, the so-called California studies, we entered the competition for the study on waste management and were selected.

Throughout our work in this study, our work on water resources for the Office of Saline Water, and our work in life sciences activities, we have become vitally interested in pollution abatement and are resolved to make whatever contribution we can to this most significant problem.

I would like now to talk about the California waste management study. This was the first small step toward pollution of what is now, and will certainly be in the future, a very serious problem for the State of California.

The study addressed itself to all kinds of wastes—gaseous, liquid, and solid. Such an application is necessary if we are to arrive at the best total solution to the problem throughout the country.

The Committee on Pollution of the National Academy of Sciences—National Research Council states in a report, "Waste Management and Control":

> The difficult job of determining an optimum balance of competing requirements must be approached from a systems point of view. The systems approach must consider the interrelationship of land, air, and water. Too often municipalities get rid of solid wastes by incomplete burning, which may solve land disposal problems, but fouls the air. We must consider the assimilative capacity of water, air, and land taken together as a single entity and in relation to the plants and animals that live there.
>
> The assimilative capacities vary with such factors as the tidal flushing of bays, the flow of rivers and the windiness of locality.

Now, in this first attempt to apply systems analysis to waste management problems in California we found our efforts hindered by inadequate definition of environmental objectives, the lack of pertinent data and lack of generalized analytical models.

However, we could readily identify sources of agricultural, industrial and domestic wastes, and it was clear that by redesign of existing plants, control of design of future plants, development of special waste disposal systems, much of the effluent and residues of California industry and agriculture could be eliminated or rendered less noxious. But at what permissible cost, and over what time period, and by what means of administration and control, and, perhaps most important of all, to what degree?

These questions are not easy to find the answers to. Our studies showed that if we used the existing systems of waste management, merely continuing present methods and expanding these methods to cope with greater demands we see in the future, the annual cost in the year 1990 of treating industrial wastes, commuting greater distances on superclogged superhighways, refurbishing facilities and residences that have been deteriorated by polluted environment will be approximately $8 billion annually.

Systems engineers making use of improvements possible with today's technology or potential improvements from advanced technology, would reduce the approximate annual cost, we figured, in 1990 to $3 to $4 billion. So that is a substantial reduction. It is about equal to the current California State budget.

To evaluate the utility of regional models, the Sacramento area was studied in some detail and simplified and experimental simulation models for digital computers were constructed to predict air quality conditions and to locate sewage treatment plants and scale them for size.

From this and other work we concluded that modeling techniques are well enough advanced to apply to a large region to get better demonstation of the usefulness of the systems approach.

The major conclusions of our study were:

First, that in light of estimated compositions and quantities of waste in the next 25 to 30 years, the continued substantial degradation of environment will occur if present waste management practices are continued.

Second, that urgent research and development is required to overcome these three principal hindrances of comprehensive systems analysis of waste management today. First, the lack of meaningful environmental objectives which define output requirements of system. Second, the lack of correlation between characteristics, quantities, effluents and the deluge of environmental pollution. Third, the lack of generalized computer-type models of three basic elements of waste management system: the input function, the processing function, and the environmental assimilative function.

I think our waste management study and other California studies have given a positive indication that aerospace techniques will be a useful tool in creation environment in the next few years. The central advantage offered by this tool is the ability to provide decision-makers with more facts on which to base their decisions.

I now would like to turn my attention to comments on the subject with which your committee is concerned at the moment, the adequacy of presently available science and technology for pollution abatement.

From our vantage point at Aerojet General, and based upon our very limited experience with a truly immense and fantastically complex problem, the adequacy of presently available science and technology for pollution abatement cannot be quantitatively assessed. I submit, however, that the following two quantitative statements can be made with some confidence they are right.

The first is that presently available science and technology has not been fully applied to pollution abatement as yet.

The second statement is that the pollution abatement problem will require new and improved technology to achieve acceptable solutions in the future.

Now, if we try to design a specific course of action based on these statements in order to perhaps arrange for improved application of presently available science and technology and establishment of appropriate research and development program to yield required new and improved technology, we very soon confront the same obstacle we found in our waste management study—the goals we are striving for are not well defined.

If we consider the establishment of goals we find much work remains to be done, and there is no clear channel for its accomplishment.

Now, in this country of ours we have organized ourselves to make effective attacks on other gigantic problems—the defense of our country and the maintaining of our country's leadership in space exploration, to mention two, and we can and will organize ourselves to make an effective attack on pollution abatement.

The leadership of the Federal Government is required to assign appropriate priority to pollution abatement among our other national objectives and to assign clear responsibilities and authorities so that the establishment of goals, and the implementation of programs to achieve these goals can proceed in an orderly fashion.

Now, as we strive toward more effective pollution abatement on a national scale we should proceed immediately on national projects to further develop our techniques of the application of systems approach to pollution problems.

There was a review of the California studies conducted in a series of meetings at Williamsburg in which panel experts convened to spend

a couple of days with the authors of the studies examining what was done and to figure out what should have been next.

In the review of our waste management study, I am glad to say the experts in the field concluded that indeed it looked as though there is value in this systems approach, and that the next step which should be taken is that a region should be selected for an indepth study to get further evaluation of the systems approach.

I think the systems approach will be a valuable tool to add to other available resources which will be necessary to conquer the threat of pollution to the well-being of our citizens. It is not a panacea. There will have to be other resources also to conquer the threat of pollution to the well-being of our citizens.

Thank you very much.

Mr. BROWN. Thank you, Mr. Rogers. We appreciate your testimony, particularly in view of the contribution which Aerojet has already made in this field. I am sure, speaking for both Congressman Bell and myself, that the aerospace industry in southern California will continue to play an expanded role in this field, and this is part of the exploration we are interested in.

Congressman Bell?

Mr. BELL. I think, Mr. Rogers, following up on the statement my colleague made, Aerojet did pay part of the cost of the California study?

Mr. ROGERS. Yes, sir.

Mr. BELL. Would they continue to do this in pollution work in order to gain experience for their company or something?

Mr. ROGERS. Of course it depends upon a business evaluation of what the opportunity is. Although the waste management study might be considered somewhat far out to our stockholders, we considered this was a worthwhile enough potential area to match the State funds in preparation of the study, which we did.

Each case that comes along I am sure will be evaluated on its own merits.

Mr. BROWN. If you felt the market would increase for this type of study, you might be interested in doing some in-house work on that?

Mr. ROGERS. That's right.

Mr. BROWN. Mr. Rogers, I will make the statement to you I did to other witnesses. We recognize the shortage of time this morning. I will not take up any more of your time this morning.

I want to thank you again for being here, and I am sure this is going to be of great benefit to the committee.

Mr. ROGERS. Thank you.

Mr. BELL. I also want to thank you.

Mr. ROGERS. Thank you.

Mr. BROWN. There are two or three people who were not invited as witnesses, but have asked to appear. The committee is not at all seeking to exclude witnesses. We are merely handicapped by the mechanics of time.

Any witness is free to submit a written statement to the committee, if you wish to do so, and in the next 10 minutes or so I am going to try and call on the persons who have indicated a desire to make a brief personal statement.

If I may be permitted to choose the order, I think I will ask Dr. Clark, who had previously inquired about coming to Washington, if he would like to come forward for just a moment.

Dr. Clark, we are happy to have you here. We don't know the gist of your testimony, but whatever it is, I am sure it will be welcome. You may address the committee.

STATEMENT OF DR. WILLIAM D. CLARK, TECHNICAL DIRECTOR, DYNA-THERM CORP.

Dr. CLARK. In view of the shortage of time, I will make it as brief as possible, which is sort of akin to trying to explain nuclear physics in 5 minutes.

Mr. BROWN. We appreciate that.

Dr. CLARK. I have been engaged many years in research involving the use of cryogenic hydrogen as a fuel for internal combustion engines and for small powerplants.

This came about as part of my work at Los Alamos Scientific Laboratory when we were speculating on how we might apply atomic energy to small powerplants such as automobiles.

It became apparent quickly that we could not foresee having 50 million small reactors on the Nation's highways in automobiles in the near future.

The nature of atomic energy is such it lends itself only to large powerplants. The only reasonable route seemed to be the construction of large nuclear powerplants, the storing of the energy from these large nuclear powerplants and some intermediate substance which could be distributed throughout the United States in smaller powerplants such as for automobiles. The plant came out to be in electrolysis of water and the distribution of cryogenic hydrogen as fuel.

Hydrogen, as you know, joins combination with oxygen in the air and the product is water. There are no pollutants involved at all.

Now, admittedly, this is a far out concept. This will take years and years of research.

The role of the Federal Government, in my opinion, should be the funding of some of this research.

Even if the programs of Mr. Fuller and Mr. Grant are 100 percent successful, and we succeed in generating a device we can place onto an automobile, that would result in stoichiometric reaction between gasoline and air which would mean of course that the products would be carbon dioxide, gas and water; the amount of carbon dioxide, gas and water we would be dumping into the atmosphere is small in itself. In itself it would become a pollutant in the greenhouse effect with large amounts of CO_2 in the air, and would affect the entire temperature of the earth.

These are briefly the points I wish to make to the committee. Being a technical man, I am interested in research and development. I feel that the Federal Government should establish some research program to investigate the entire energy picture.

With regard to the systems approach that the gentleman from Aerojet was speaking of, the fact is that when man uses energy there will be a waste. The laws of thermodynamics demand that, but by careful management we can arrange this waste to be in such a form that we can best handle it.

For instance, in the scheme that I have outlined, the waste of course is the fission products from the reactor, but we can handle these fission products in a much more efficient fashion because we get tremendously small amounts of fission product waste from nuclear energy for the production of a tremendous amount of energy. We can concentrate these into relatively small packages, and the thought of, shall we say, depositing these in outer space where radioactivity is no stranger is not at all out of the realm of possibility, and it is definitely economically feasible. We are talking of disposing of 10 or 15 pounds of reaction fission products after it has produced several hundred million megawatt-hours of energy.

I think I should give the other people a part of the time who want to be heard. I would like the opportunity of meeting with you two gentlemen in Washington and discussing this in some detail.

I have presented this program to Congressman Overton Brooks over the years, and I just had a conference with Senator Clinton Anderson at his home discussing these issues. I would like to go into it in more detail, and I am, frankly, not quite at home without a blackboard.

Mr. BROWN. We appreciate your willingness to come here this morning, Dr. Clark, and present this to us. I think Mr. Bell and myself are both receptive to innovative ideas of this sort. We are looking for new ideas, and may I assure you on my own part of our willingness to meet and discuss this with you.

Dr. CLARK. The last thought I would like to leave is that my preliminary studies, with the cooperation of Mr. Fuller making a considerable amount of his information available to me, led me to believe Los Angeles is on the brink of a disaster regarding smog.

Mr. BROWN. Well, I would not be at all surprised if you were right.

Any further questions?

Mr. BELL. I am sorry there wasn't more time to hear further discussion of this. I have heard of your work in the past, and I hope you have the opportunity to come back and bring this problem up to us in Washington, and expand on it.

I hope that you will give us maybe some written material and additional information with your thoughts in them.

Dr. CLARK. I will forward a few reports I have gotten up on the subject to the committee for your reading and reaction.

(Additional material furnished may be found in committee files.)

Mr. BROWN. Thank you very much.

Dr. CLARK. Thank you.

Mr. BROWN. Mrs. Slade, would you like to make a brief statement at this time?

Mrs. Slade, you represent the Stamp Out Smog Committee?

STATEMENT OF MRS. SHERMAN SLADE, STAMP OUT SMOG COMMITTEE

Mrs. SLADE. That is correct. We represent about 400 organizations thoughout the State of California dedicated to eradicating smog. I suppose we speak for the people as much as anyone could.

I would like to briefly say, while we have had a cooperative Governor and supervisors, you can see the problem is still with us. We are happy for the great interest the Federal Government has shown recently.

We want to emphasize that the public is not apathetic. We have heard this said so many times. It may seem apathetic on a rainy Monday morning, the first day of school. Most of them are highly confused about the highly technical nature of this problem, and I think they would support any solutions.

We would recommend more Federal research money. We would like to see it channeled through people already knowledgeable in the field, your universities, and the people who have done pioneering work, but we could use a great deal more.

I would like also to say one word about natural gas. I have written Congressman Bell about the subject. We feel one thing the Federal Government could do is let the urban areas with pollution problems have all the natural gas they need. We feel the Federal Government is being old fashioned in hoarding the natural gas, the supply of which, I understand, is increasing all the time. We could use some more gas.

Thank you very much.

Mr. BROWN. Thank you very much for your statement.

Mr. BELL. Thank you.

Mr. BROWN. I might say if hearings could eliminate smog, it would have been eliminated many years ago.

Mr. George Fisher, the California Taxpayers Council, asked to speak briefly also. We will welcome a statement from him.

STATEMENT OF GEORGE FISHER, SOUTHERN CALIFORNIA TAXPAYERS COUNCIL

Mr. FISHER. Thank you, Mr. Chairman.

I don't want to appear sarcastic or disharmonious, especially toward you, Congressman Brown, because you were one of our stanch supporters in the years gone by in introducing legislation that would have eliminated effluent content of gasoline, and if that law had been successful, we would have less of a problem now, but the oil lobby was too much, and politics, and we are still fumbling around with smog.

I only have time to introduce myself.

I am George Fisher. I am secretary of the Southern California Taxpayers Council for Simplified Government.

Over the past 20 years we have been studying and writing about smog, and we give no quarter to anyone when it comes to information, technical, political and otherwise, with regard to smog.

I would like to reiterate—I would like to make these two points. It is better in speaking in a short period to make only a few points. So I will just make two.

I would like to say that first over the past 20 years we have kept reiterating that smog can be eliminated instantly, if the health departments all over the country would enforce their own laws and abate a nuisance. That is all they have to do, and all this multibillion-dollar racket would be eliminated immediately.

That is the first point.

The second point I would like to make is with regard to the exhaust devices. This is a little more technical, but I will make it just as simple as I can. The exhaust devices on which the American public is going to spend upward of $500 million a year is a complete fraud and a hoax, and I will tell you why very briefly.

Dr. Haagen-Smit stated in 1950 as a cause of smog our gasoline has increased its effluent content twentyfold. He stated that in 1950 that as a cause of smog the effluent content of our gas has increased twentyfold. Now, in formulating the designs for this exhaust device that increase is completely ignored. There is no mention made of it whatever in the formula.

In other words, those who have devised that fraud have pretended that the effluent content of our gasoline has remained constant. That is a fact that is to be found in chapter 17 on page 98 of the Standards for Motor Vehicle Exhaust.

Now, that can be very easily rectified. Dr. Haagen-Smit was here and he could talk to it. It is tragic he doesn't remain, but those who make a living from smog, they spend an hour or two talking to committees constantly, they get paid for it, but those who attempt to represent the taxpayers, such as I, we are shoved to the rear and offered a couple of minutes, and of course that is the reason why we still have smog, because we bring the taxpayers' viewpoint.

Now, I want to mention just one more thing, and that is to get to the point of this meeting. The point of his meeting today as you are trying to find out how to spend some money on Aerojet's systems management. That very patently is the purpose of the meeting. You want to find out if and how the Federal Government can let Aerojet into the account and spend some more of the taxpayers' money.

I am going to oppose that, and I am going to tell you why. When smog first came way back in 1943 we enunciated all these things that I have said now about the fraudulence of the entire program from the beginning to the end. We have it documented, every phase of it, political and scientific. We have it documented in our literature which is available to anyone. We can show that every piece is a fraud, and now Aerojet wants to get into the act and spend money.

As good engineers, we never miss a point. We have taken Aerojet's study from the Von Karman Center and have studied it exhaustively, and when it comes to air pollution, when it comes to exhaust devices, they have simply copied word for word, verbatim, in their study, copied word for word the program of the California Motor Vehicle Pollution Control Board.

In other words, the same fraudulence that the California Motor Vehicle Pollution Control Board has been handing out for the last 6 years, the Aerojet-General has simply copied. In other words, they have no better ideas, and we, the taxpayers council, we don't like to see our money spent for that kind of thing.

We would like to see this $500 million the American public is going to pay, beginning in 1968—we would like to see some concrete results from that. As I pointed out, there can be no concrete results because scientifically the thing is a hoax and a fraud.

Every Detroit engineer knows that. I attended the SAE convention in Detroit a few years ago, and when those engineers sit around a glass of cold beer in a club, they laugh at this. They think we are a bunch of mental patients out here in Los Angeles.

In the Automotive News for January 16, 1964, there are some of the quotes from those engineers. They think we are a bunch of idiots for suggesting such a thing.

I happen to have with me some summaries of our earlier literature. The title of this is "Smog Control—Political Fraud." Anyone who wants to bring themselves up to date on it may have a copy.

I would like to leave with you one point that we very definitely oppose and that is the systems engineering industry getting into this smog control act with taxpayers' money, unless they can show something very concrete and very different from the fraud that the Motor Vehicle Pollution Control Board has already handed to us. Unless they can show us that, we are definitely opposed to it. I don't know what good it will do, but I do want the record to show we are opposing it.

Do any of the members have any questions?

Mr. BROWN. Mr. Fisher, we appreciate the statement you have made. I don't know that we necessarily agree with all of them, although I have been in the past and still am sympathetic with some of the points you made.

I do want to apologize for the time problem, but I did deliberately shorten the time of some of the earlier witnesses so we could get to you, even this briefly. I wish it could have been for longer. I reiterate my invitation for you to expand on your testimony, if you wish to do so.

Mr. Bell?

Mr. BELL. Mr. Fisher, I appreciate your coming before the committee, and, in a similar vein as my colleague, I may not agree with everything you say, but there are some points I think certainly are valid and worth considering.

I hope perhaps sometime you could come to Washington and testify at greater length in this matter. I think it would be of benefit to hear a full disclosure of your views, rather than giving you here just 3 or 4 minutes to do it. If you could come back, I am sure we would be glad to hear further from you.

Mr. FISHER. If I were invited to Washington, that would be the supreme triumph, because we could then get a genuine sounding board. We would be happy to pay our expenses for sending a delegation back there any time we are invited to testify before any commission in Washington, because we would really feel we were getting somewhere then. Thank you for the invitation.

Mr. BROWN. Thank you, Mr. Fisher.

This will conclude our hearing this morning. I am grateful for all witnesses who have appeared before us and for the members of the audience who have been so patient this morning.

The meeting is adjourned.

(Whereupon, at 12:15 p.m., the subcommittee was adjourned.)

(The prepared statement of W. L. Rogers follows:)

PREPARED STATEMENT OF W. L. ROGERS, VICE PRESIDENT, VON KARMAN CENTER AREOJET-GENERAL CORP.

Mr. Chairman, members of the commitee, thank you on behalf of Aerojet-General Corp. for the opportunity to testify before you on the subject of technology and pollution abatement. The magnitude and gravity of the problem certainly confer an obligation on all organizations that can make a contribution to dedicate their efforts to the tasks that confront us in the control of pollution and the management of waste.

Early in 1965, Governor Brown of California initiated a series of pioneering efforts to investigate the applicability of the systems approach to special social-economic problems. Areojet was selected to conduct the study of waste management. Among other assignments, we were required in the study to evaluate current technology as it relates to pollution and waste control.

However, before I discuss this subject in detail, I would like to define the term "systems approach." It is simply the name for a technique of evaluating all the factors involved in a complex problem and determining possible optimum approaches. "Optimum" is a flexible term, but in general it means the best answer consistent with the results desired, the current state of technology, the expenditure required, and the time available. This approach, initially developed by the telephone companies, has been further refined by the aerospace industry, whose member companies have almost continuously addressed themselves to major problems of defense and space technology which are characterized by great complexity and by financial, technological, managerial, and time constraints.

Let me hasten to state that the systems approach is by no means a magical solution to our technical problems or a substitute for management experience. It is simply an efficient technique for data gathering and analysis which permits us to examine and evaluate huge amounts of complex and interrelated data and to direct intricate research, development, and production tasks in the most economical way. In this role, it can help us do the following:

1. Define the problem in terms of the requirements, i.e., input, output, conditions of use, reliability, and constraints.
2. Identity functions which must be performed to satisfy requirements.
3. Define the interrelationships of the functions, feasible trade-offs, and the interfaces between subsystems.
4. Optimize functions.
5. Formulate plans to achieve the desired output within the constraints.
6. Define the development activities needed to produce the final operating system, or intermediate data.
7. Design the final operating system based on previous input.

Aerojet-General has successfully used the systems approach in many large programs; in defense, space exploration, nuclear energy, water desalination, material handling, and the life sicences. Some of our well-known systems programs include those for the development of liquid, solid, and nuclear rocket engines, such as the Polaris, Titan, Minuteman, Nerva, and Apollo. In addition, Von Karman Center, which I represent, is currently applying systems engineering techniques in a number of other areas, including:

Development and production of Mark 46 torpedoes for the U.S. Navy.

Development and manufacture of space payloads for the Air Force.

Design and development of the SNAP–835-kilowatt space power supply for NASA.

Various programs in the life sciences, including the toxicology laboratory for the Air Force at Wright-Patterson Air Force Base.

Research and development for the Office of Saline Water on reverse osmosis—one of the more recently developed methods of desalting sea water and purifying polluted water.

These and other development areas occupy the attention of a staff of approximately 4,400 people, including some 1,700 engineers and scientists with a broad range of specialities and capabilities.

I'd like to begin my discussion of the adequacy of technology for pollution abatement with a brief review of the principal conclusions of the California Waste Management Study. I believe that they bear directly on the question and that they apply not only to California, but to the Nation as a whole.

1. Pollution is the most obvious result of a larger problem—that of our present failure to satisfactorily manage liquid, solid, and gaseous wastes.
2. Continued, substantial degradation of the environment will occur if present waste-handling practices are perpetuated.
3. Research and development are urgently required to achieve the following objectives:

The establishment of correlations between characteristics and quantities of effluents and the degree of environmental pollution.

The development of the economics of pollution; i.e., the financial penalties attributable to pollution compared with the costs of control.

The establishment of meaningful and environmental standards, which in turn define what our systems must be able to do.

The construction of general computerized models of the three basic elements of a waste management system: input to the system, processing through it, and assimilation by the environment.

4. The only technically and economically efficient way to manage these wastes is through the development of a waste management system organized on a regional basis, transcending artificial political boundaries, and controlling all forms of waste.

Our study also showed that if California continues to use existing systems, merely expanding them to meet greater demands, the total costs for the year 1990 deriving from wastes of all kinds will be about $8 billion per year, and the environment will be more polluted than it is today. (The current total budget of the entire State of California is about $4 billion a year.) Employing systems engineering, and using improvements possible with today's technology or potentially available from advanced technology, we believe that the cost in 1990 could be reduced to about $3 or $4 billion per year, and in addition to lower total costs, we would have a cleaner, more pleasant environment.

In this connection, I would like to amplify my earlier statement that the problem of pollution must be viewed in the larger context of waste management in general. The distinction is not merely semantic, but has substantial practical consequences.

I quote from the report "Waste Management and Control" issued this year by the Committee on Pollution of the National Academy of Sciences National Research Council.

"The difficult job of determining an optimum balance of competing requirements must be approached from a systems point of view. The systems approach must consider the interrelationship of land, air, and water. Too often, municipalities get rid of solid wastes by incomplete burning, which may solve land disposal problems but fouls the air. We must consider the assimilative capacity of water, air, and land taken together as a single entity and in relation to the plants and animals that live there. The assimilative capacities vary with such factors as the tidal flushing of bays, the flow of rivers, and the windiness of the locality."

Pollution, in short, is not a simple, straightforward problem. Population is not only increasing in most sections of the country, but is also constantly shifting about, usually making established waste control systems inadequate. Our present controls of waste are so fragmented that all too often little is done. Our industrial techniques are constantly changing, resulting in new waste problems as well as requiring new control equipment if minimum disposal costs are to be realized. The pollutants are dynamic, flowing in air and water across county, State, and National borders. The waste is itself constantly changing from gaseous to liquid and solid, from liquid to solid and gaseous, and so on, making it difficult and expensive to control once it has left its source. Indeed, we generally do not know what the effects of a given pollutant are, and hence whether to insist on controlling it. Finally, our esthetic demands are becoming of greater importance. Not only are we concerned about preventing undesirable health effects, and lowering waste treatment costs, we are also concerned about such intangibles as clear air and clean, sparkling water.

Another major problem, frequently unrecognized, is that in most cases we do not even know what a pollutant is. To define one we must not only know its chemical composition, but also:

1. Relate this data to other possible pollutants being added at the same time.
2. Define its quantity and rate of addition.
3. Specify its precise location.
4. Specify the volume, composition, and physical and chemical characteristics of the receiving stream or body of air.
5. Determine the capacity of the receiving medium to assimilate or change the pollutant both along its line of flow and at its terminus.
6. Specify the uses that the receiving medium will be put to.

Obviously, such determinations for the hundreds of potential pollutants which may be added during the course of a given day to a given stream or airshed would be very difficult and expensive, even if we knew all the interrelationships, could predict what the stream (or air) flow might be, and could measure the quantities in the first place.

Up to this point, I have attempted a candid assessment of the difficulties we face in merely knowing what we want to accomplish, let alone doing it. But in spite of imperfect knowledge, we must act and act now. The longer we wait, the more serious the situation becomes.