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91-17 **AIR POLLUTION CONTROL RESEARCH
INTO FUELS AND MOTOR VEHICLES**

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HEARING
BEFORE THE
SUBCOMMITTEE ON
PUBLIC HEALTH AND WELFARE
OF THE
COMMITTEE ON
INTERSTATE AND FOREIGN COMMERCE
HOUSE OF REPRESENTATIVES

NINETY-FIRST CONGRESS

FIRST SESSION

ON

H.R. 12085

A BILL TO AMEND THE CLEAN AIR ACT TO EXTEND THE
PROGRAM OF RESEARCH RELATING TO
FUELS AND VEHICLES

JUNE 19, 1969

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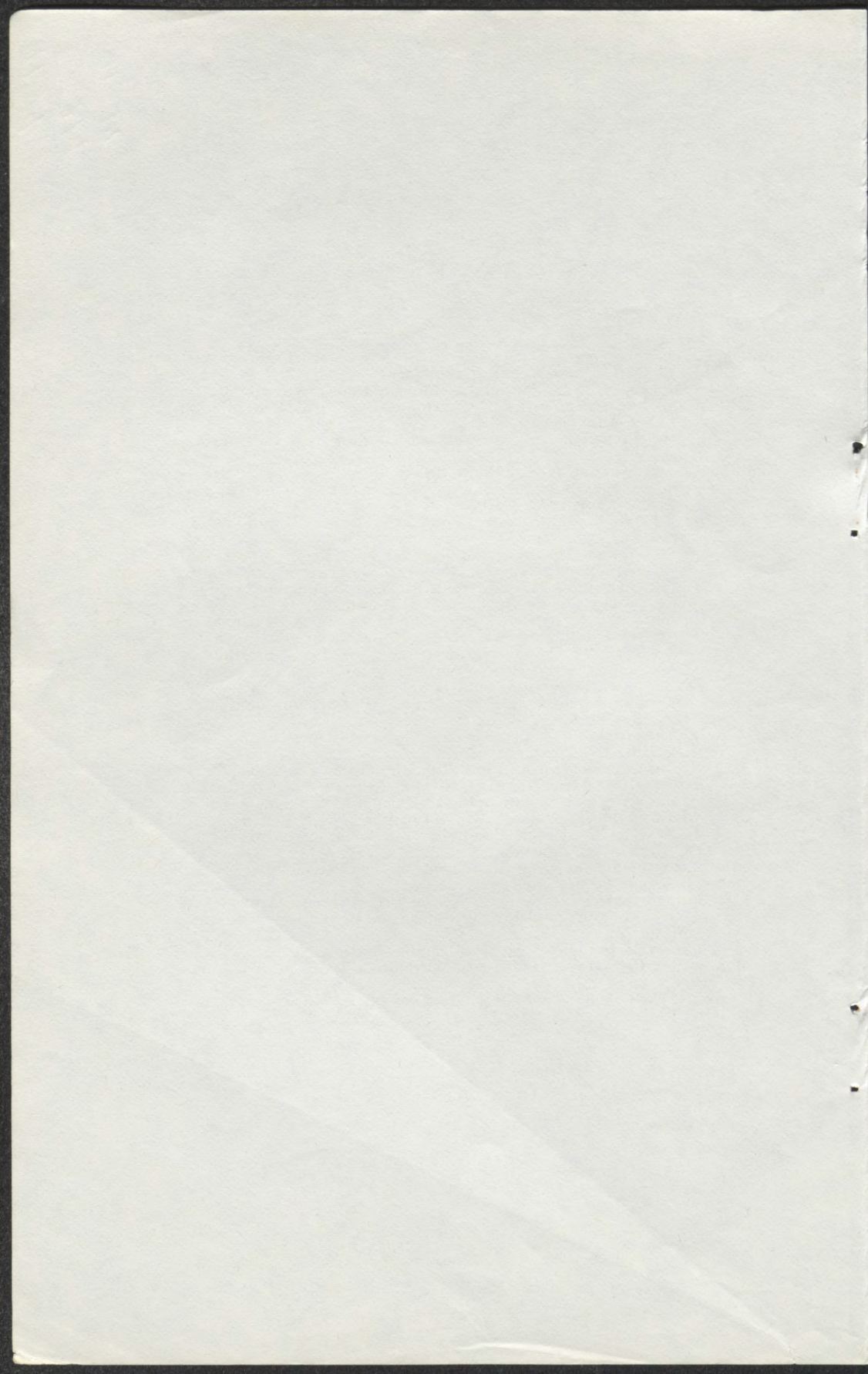
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AIR POLLUTION CONTROL RESEARCH INTO FUELS AND MOTOR VEHICLES

THURSDAY, JUNE 19, 1969

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON PUBLIC HEALTH AND WELFARE,
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
Washington, D.C.

The subcommittee met at 10 a.m., pursuant to notice, in room 2318, Rayburn House Office Building, Hon. Peter N. Kyros presiding (Hon. John Jarman, chairman).

Mr. KYROS. The subcommittee will please be in order.

The hearings today are on H.R. 12085, introduced by Chairman Staggers on June 11, to provide a 1-year extension of section 104 of the Clean Air Act.

When the Air Quality Act of 1967 was enacted, section 104 was placed in the act in order to provide specifically earmarked funds for research programs involving fuel and vehicles. This program is scheduled to expire on June 30, 1969, whereas the remaining authorization for appropriations under the program is scheduled to expire June 30, 1970.

The bill before us today would provide a simple 1-year extension of the section 104 authority to June 30, 1970, thereby providing a uniform expiration date for all appropriation authorizations under the Clean Air Act.

At this point there will be included in the record the text of the bill and Agency reports thereon.

(The text of H.R. 12085 follows:)

[H.R. 12085, 91st Cong., first sess., introduced by Mr. Staggers on June 11, 1969]

A BILL To amend the Clean Air Act to extend the program of research relating to fuel and vehicles

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section 104(c) of the Clean Air Act (42 U.S.C. 1857-1) is amended by striking out "for the fiscal year ending June 30, 1969" and inserting in lieu thereof "for each of the fiscal years ending June 30, 1969, and June 30, 1970".

Mr. KYROS. I understand our first witness this morning will be Dr. John T. Middleton, Commissioner of the National Air Pollution Control Administration.

STATEMENT OF DR. JOHN T. MIDDLETON, COMMISSIONER, NATIONAL AIR POLLUTION CONTROL ADMINISTRATION, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE; ACCOMPANIED BY IRWIN L. AUERBACH, SPECIAL ASSISTANT FOR LEGISLATIVE AFFAIRS; AND RAYMOND SMITH, ASSISTANT COMMISSIONER FOR PROGRAM DEVELOPMENT, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Dr. MIDDLETON. Thank you, Mr. Chairman.

I would like to read a short statement if I may, sir.

Mr. KYROS. Certainly.

Dr. MIDDLETON. Mr. Chairman and members of the subcommittee, I am very pleased to have this opportunity to testify on H.R. 12085. This bill, as you have said, would extend for one year the authorization of appropriations under section 104 of the Air Quality Act of 1967. I will say at the outset that enactment of this bill would not result in any increase in the National Air Pollution Control Administration's proposed budget for fiscal 1970, but rather would enable us to continue to make appropriate use of certain special features of section 104.

In adopting the Air Quality Act, the Congress set up an inter-governmental system for dealing with air pollution problems on a regional basis. State and local governments have a major share of the responsibility for making this system work. They have a particular responsibility for dealing with air pollution problems arising from the many industrial, commercial, and other stationary sources located in virtually every urban community in the Nation and in many small towns and rural areas.

The activities of State and local agencies depend in part on the availability of practical and economical techniques for preventing and controlling air pollution arising from stationary sources. And, similarly, the national program of regulatory action to control air pollution from motor vehicles also depends on progress in the development of appropriate control techniques.

It is essential, then, that the Department of Health, Education, and Welfare continue the research and development activities authorized by the Air Quality Act, particularly those activities relating to the air pollution problems arising from the combustion of fossil fuels to produce electric power and heat and from the operation of motor vehicles. Together, fuel combustion sources and motor vehicles account for more than two-thirds of all discharges of pollutants into the Nation's air resource each year.

Under section 104, the National Air Pollution Control Administration currently is conducting efforts to develop and demonstrate techniques for the prevention and control of sulfur oxides pollution, a major national problem arising in large part from the combustion of fossil fuels. This effort is a coordinated Government-industry program involving not just the National Air Pollution Control Administration but also several other Federal agencies and more than 70 organizations in the private sector.

A more modest program relating to motor vehicle pollution control also is being conducted under section 104. This program includes continued efforts to develop improved means of controlling emissions from the internal combustion engine and initial work on the development of alternative propulsion systems for motor vehicles.

Special features of section 104 include the fact that funds made available to us can remain available until expended. This flexibility is useful in the planning and scheduling of research and development and demonstration projects which may extend beyond the end of a fiscal year.

A second feature of section 104 is that which clarifies the legal implications of supporting projects involving construction and installation of pollution control equipment on private property for the purpose of testing. Very often, industrial plants are the best possible sites for making a realistic evaluation of the economic and technological feasibility of new processes for the control of problems such as sulfur oxides pollution.

As I noted at the beginning of my statement, enactment of H.R. 12085 would not result in any increase in the National Air Pollution Control Administration's proposed budget for fiscal 1970. Funds for the types of research and development ordinarily conducted under section 104 can be appropriated under section 309 of the Air Quality Act; indeed, in view of the imminent expiration of section 104, such a shift of funding has been included in the revised 1970 budget. Section 309, however, does not contain the special features that are included in section 104.

As you know, Mr. Chairman, authorizations in section 104 are due to expire at the end of the current fiscal year. Section 309, on the other hand, runs through fiscal 1970. While extension of section 104 is not necessary, if the Congress determines that the proposed 1-year extension is desirable, we would not object to its enactment.

Mr. KYROS. Thank you, Dr. Middleton.

Before I inquire if there are any questions, let me ask you this question first:

What is the total appropriation authorization for fiscal 1970 under section 309 of the act?

Dr. MIDDLETON. The total authorization under section 309 of the Clean Air Act, as amended, is \$134.3 million.

Mr. KYROS. And this proposed extension of section 104 would be simply continuing the funds or the authority that was contained, without any additional fund in section 104?

Dr. MIDDLETON. That is correct.

Mr. KYROS. Before I proceed any further, let me ask Mr. Preyer if you have any questions.

Mr. PREYER. No, Mr. Chairman.

As a freshman member of the committee and not having been in on the Air Quality Control Act, I am here to learn from you, Dr. Middleton, and I enjoyed your testimony. It seems very convincing to me.

Dr. MIDDLETON. Thank you very much.

Mr. KYROS. Mr. Skubitz.

Mr. SKUBITZ. Dr. Middleton, how much money was appropriated or allocated for research under section 104(c) for fiscal 1969?

Dr. MIDDLETON. We are asking \$21.9 million to do work in fiscal 1970 under section 104. That is about the same amount that we have had for the past few years.

Mr. SKUBITZ. In other words, you were allocated \$18.7 million in fiscal 1969?

Dr. MIDDLETON. Excuse me, I did not get your question correctly. It was \$18.7 million in 1969, this present fiscal year.

Mr. SKUBITZ. And how much have you spent?

Dr. MIDDLETON. We expect to have all of the money accounted for, including that which we have set aside for carrying forward so that we can go through with the research projects which require multi-million dollar expenditures.

I am saying we have not expended all of that appropriated, but we have set aside those sums where we have a clear anticipation for expenditure and expect to set forth contracts in early fiscal 1970.

It is this very desirable feature of section 104 that allows us to take advantage of the real achievements in research and development as they come along. It is very difficult, I think you can understand, to program month by month the achievements that come in research and development.

This way, section 104 allows us to take care of the breakthroughs and the knowledge that becomes available.

Mr. SKUBITZ. That is all, Mr. Chairman.

Mr. NELSEN. Dr. Middleton, recently I talked to a gentleman working with a firm that is doing some work in manufacturing of facilities for the control of air pollution. There are certain design standards established by the States and certain standards by the Federal Government.

He claimed that the problem they are up against is the increasing number of requirements in the area of design and testing. Is there an available list of testing procedures or methods and design standards?

Dr. MIDDLETON. Yes, Mr. Nelsen, there is a great deal of information that bears on this.

We can supply it to you so that you may convey it to your interested person. I would like to point out that as you unquestionably know, the Clean Air Act says that the primary responsibility for air pollution control rests with the State and local governments.

The designation of air quality control regions is now underway. There are 13 that have been designated so far, and we expect to have designated 57 by the end of 1970. That is fiscal 1970.

We have published criteria documents for sulfur oxides and particulate matter. These describe the effects of those contaminants at various dosages, exposure times, and concentrations. We have also published reports on control techniques, the ways in which those pollutants may be controlled. These have been sent to the States and provide the basis for the States to develop standards that are consistent with the criteria and control techniques.

So you may expect, since there is a time compliance schedule of 15 months from the date of issue that standards for the areas designated will be established by the States.

It is clear that the Governors of the affected States are responsible for developing standards. If there are differences, it will soon be ironed out on a State and local basis.

Mr. NELSEN. Would the States have the equipment to test? This must be quite a difficult process. Do the States have facilities to make these tests?

Dr. MIDDLETON. It is a very interesting question, and it takes a mixed answer. There are some States that have this capability, but most States do not.

In an effort to assist the States in the development of their standards, and the emission reduction strategy or the implementation plan, the National Air Pollution Control Administration is providing technical assistance and information to the States, to assist them in the very things that you are asking questions about.

Mr. NELSEN. Is there any possibility that you get into so many areas nowadays that there is a need for national standards? Maybe uniform national standards become more and more of a desired objective since we go in so many different directions if we don't have some flat uniform standards. At the same time we must recognize the desires of the various States who may want to establish more stringent standards?

It would seem to me that we may be approaching a situation where there might be a need for national standards with the States placed into different categories. This, of course, is looking to the future, but you may want to comment on this observation.

Dr. MIDDLETON. It is an interesting observation. The Department of Health, Education, and Welfare will be supplying a report to the Congress dealing with the issue of national emission standards, and I think that after you have an opportunity to read this, there may be an opportunity for further discussion.

I think the point that is being made here with your statement on standards reinforces the need to have research and development go forward for control techniques which the States will be required to use.

There may be the desire to have a good quality air, but without the control techniques which will permit its achievement, this aspiration cannot be fulfilled.

I would like to be certain that we can provide that know-how to the States through the Federal Government's activities with the private sector in developing these tools.

Mr. NELSEN. The gentlemen to whom I referred earlier felt that they were in a difficult position because a product that they manufacture might be an acceptable one in Minnesota, but not in Iowa, or Kentucky. The standards vary so much that they really are at odds to know what to do.

I note, however, that you are apparently moving in the direction of giving some assistance and guidance in this field, which I think is very commendable.

Dr. MIDDLETON. Thank you.

Mr. KYROS. Dr. Middleton, earlier I asked you about the authorization appropriation for 1970, and it was \$134.3 million. Do you know how much is requested in the President's budget for programs under the authority of section 309?

Dr. MIDDLETON. This is \$95.8 million, Mr. Chairman.

Mr. KYROS. Were any funds requested in the budget for section 104 programs, subject to the authorization by legislation similar to this bill, and if so, in what amounts?

Dr. MIDDLETON. Yes; we had asked for \$21.9 million under the authorization of section 104 in the 1970 budget. At that time we had anticipated making a request for extension and it is in this area that we now have the concern that your committee is considering.

Mr. KYROS. Is the \$21.9 million that you now speak of, under section 104, included in the total of \$95 million?

Dr. MIDDLETON. Yes; it is.

As I told you, the testimony before you now is not asking for an increase of appropriations but, rather, it is authorization on a particular section; so the total being asked is that which I said, \$95.8 million.

Mr. KYROS. If this or similar legislation is not enacted or adopted by the Congress, would this have any effect upon the programs of the Department relating to research which are currently being conducted?

Dr. MIDDLETON. Mr. Chairman, as the discussion I have given to Mr. Skubitz indicated, it is true that under section 103 there is authorization for conducting research and research development. But section 104 contains, as I stated in my testimony, some important special features.

I think the Congress, through section 104, signaled the desirability of using other Federal agencies as well as the private sector. This point of indicating to the public that, yes, the Congress does have a concern of joint efforts and cost sharing where that is possible, all of this comes out rather clearly in section 104.

Of course, the other two points are that the section 104 rather clearly gives explicit discretion to the Secretary for the disposal of property that is developed on private lands in the course of development and research control techniques.

Of course, the extension of time, is of paramount importance in any such developing research program.

Mr. KYROS. Will any of the funds lapse that we are talking about here if we don't extend the program?

Dr. MIDDLETON. The fund appropriated in 1969 will, as I understand it, not lapse.

Mr. KYROS. Doctor, you say you have drawn up some report on the emission standards.

Would you provide the record with a summary of the programs conducted under section 104 and the accomplishments under those programs to date?

Dr. MIDDLETON. We would be very pleased to leave this with the committee.

Mr. KYROS. We will make it a part of the record.

(The document referred to follows:)

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE,
PUBLIC HEALTH SERVICE,
CONSUMER PROTECTION AND ENVIRONMENTAL HEALTH SERVICE,
NATIONAL AIR POLLUTION CONTROL ADMINISTRATION,
Arlington, Va., June 19, 1969.

To: For the record of hearings before the Subcommittee on Public Health and Welfare of the Committee on Interstate and Foreign Commerce, House of Representatives, June 19, 1969.

From: Commissioner, National Air Pollution Control Administration.

Subject: Summary of activities under section 104 of the Air Quality Act.

Attached is a brief summary of the progress of the National Air Pollution Control Administration's research and development activities under section 104

of the Air Quality Act. This summary includes examples of work already initiated under section 104 and contemplated for the coming fiscal year.

JOHN T. MIDDLETON.

FUEL COMBUSTION

Efforts to develop and demonstrate techniques for the prevention and control of sulfur oxides pollution constitute a major part of the National Air Pollution Control Administration's research and development on air pollution problems arising from fuel combustion.

Over the past two years, NAPCA has completed the development of a comprehensive five-year plan for sulfur oxides research and development and has moved ahead on implementation of the plan to the extent permitted by available funds. Thus, NAPCA is now managing a national program involving the participation of several other Federal agencies and more than 70 groups in the private sector and in universities. The program also includes cooperative activities with organizations in several foreign countries.

This program encompasses basic and applied research, laboratory testing, studies of economic and technical feasibility, and pilot-plant and prototype testing of sulfur oxides control techniques. NAPCA is placing increasing emphasis on full-scale prototype testing of techniques which have reached advanced stages of development. A substantial portion of the program is supported by NAPCA contracts with non-Federal organizations, but it is expected that projects involving cost-sharing by industry will account for an increasing share of the program in the months and years ahead, particularly in the area of prototype testing.

The development and demonstration of techniques for removing sulfur oxides from combustion gases represent one of the principal work areas of the program. Availability of such techniques would help to pave the way for achieving effective control of sulfur oxides pollution without imposing widespread restrictions on fuel use. NAPCA has initiated work leading to full-scale prototype testing of limestone injection processes, which potentially are applicable to many existing steam-electric power plants. Prototype testing of the dry limestone process is scheduled to begin in Fiscal 1970 at a Tennessee Valley Authority plant. A site for testing of the limestone injection-and-wet scrubbing process has not been selected as yet. Agreements regarding the handling of proprietary information have been negotiated to pave the way for evaluation of flue-gas treatment processes developed by Wellman-Lord and the Monsanto Company.

Also with respect to flue-gas treatment, NAPCA has begun work on techniques that previously have not been applied to the control of air pollution but have potential for such application. Emphasis in this work is being placed on techniques that would permit recovery of sulfur by-products. NAPCA already has initiated work on design of a small pilot plant for testing of one such process—the molten carbonate process; construction of the pilot plant is scheduled to begin in Fiscal 1970. Early initiation of work on three other new processes is under consideration.

The application of techniques for removing sulfur from fuels before they are burned offers another satisfactory way of dealing with the sulfur oxides problem. In the past two years, in cooperation with the Bureau of Mines and other organizations, NAPCA has initiated studies of the extent to which sulfur can be removed from coals mined in various parts of the country, and in Fiscal 1969, two studies were initiated to establish design parameters for prototype sulfur-removal plants.

The amount of coal lost when sulfur-containing pyrites are removed from coal constitutes an economic limitation on the extent to which sulfur can be removed. A process that would permit burning of the pyrite-coal mixtures to produce heat and sulfur by-products is being investigated by NAPCA as an approach to maximizing the extent to which coal can be economically desulfurized.

Exploration of new combustion processes that might drastically reduce the release of sulfur oxides is an important part of NAPCA's program. One of the most promising of such processes is fluidized bed combustion. The Bureau of Mines has been evaluating the basic technology of fluidized bed combustion. NAPCA's efforts are focused on evaluating its potential for sulfur-oxides reduction. NAPCA's work on this process includes cooperative activity with several foreign groups; just recently, an agreement was reached with the National Coal Board of Great Britain for exchanges of information on fluidized bed combustion.

New energy conversion techniques offer still another approach to dealing with the sulfur oxides problem. NAPCA is beginning to explore the extent to which

such techniques, possibly coupled with fuel conversion-desulfurization processes, actually can make a contribution to future implementation of sulfur oxides control programs.

MOTOR VEHICLE RESEARCH AND DEVELOPMENT

The National Air Pollution Control Administration has initiated development of a comprehensive five-year plan for research and development on motor vehicle pollution control. This plan will define specific goals and outline alternative pathways toward those goals. It will encompass not only NAPCA's research and development activities but also the related work of other Federal agencies. In addition, it will define the relationship between Federal and industry research and development work on the motor vehicle pollution problem.

Over the past two years, NAPCA has initiated or intensified its research and development on many aspects of motor vehicle pollution control. Areas in which significant new or intensified activity is underway include advanced control systems applicable to carbon monoxide and hydrocarbon emissions from internal combustion engines; nitrogen oxides control systems; techniques for controlling emissions of particulate matter, particularly lead; alternative fuels for internal combustion engines; nature and control of diesel odors; and unconventional engines for use in passenger cars.

Examples of specific projects initiated under Section 104 include:

1. A cooperative project with the National Aeronautics and Space Administration to develop a thermal afterburner for the control of carbon monoxide and hydrocarbon emissions. This project takes advantage of NASA's experience in the development and use of materials capable of withstanding extremely high temperatures. Progress in this work has a direct bearing on the technical feasibility of compliance with increasingly stringent emission standards for motor vehicles.

2. Two projects to test the feasibility of first-generation, exhaust-gas recirculation devices for the control of nitrogen oxides emissions. A demonstration grant has been awarded to the State of California to support road-testing of one type of device. Tests of another type are underway in NAPCA's own laboratories; this one was developed by Esso Research and Engineering under a contract with NAPCA. NAPCA also has initiated studies of the potential value of catalytic afterburners for control of nitrogen oxides emissions and of ways to minimize nitrogen oxides formation in designing engines.

3. Particulate matter emitted from motor vehicles includes lead, smoke, and polynuclear hydrocarbons. Fuel modification may be the most direct way to reduce or eliminate lead emissions, but NAPCA also is exploring the potential value of devices that would remove all types of particulate matter from automobile exhaust gases. NAPCA has established specifications for acceptable devices and, following review of various proposals, is negotiating a research and development contract in this area. This project will be the first step in a three-to-four year program of laboratory work, prototype hardware development, and on-the-road demonstrations.

4. NAPCA is participating in a three-year, government-industry research program to develop new knowledge of factors that have a bearing on the nature, effects, and control of motor vehicle pollution. This program is sponsored by the Coordinating Research Council; the other participants are the Automobile Manufacturers Association and the American Petroleum Institute. NAPCA provides funding for selected projects on the basis of their relationship to its own program. Projects for which NAPCA is contributing funds include studies of fuel volatility, gasoline additives, diesel odor composition, urban driving patterns, and maintenance of exhaust control systems.

5. NAPCA is contributing to the support of research by the Bureau of Mines on the relationship of fuel composition to total emissions from gasoline-fueled engines and the photochemical reactivity of such emissions. This work includes studies of fuel-emission relationships in both gasoline-fueled and diesel engines.

6. NAPCA's efforts relating to unconventional engines began more than two years ago with contract-supported studies to evaluate the potential of a variety of possible propulsion systems for motor vehicles. These studies identified the Rankine-cycle (steam) engine as one of the most promising. Accordingly, NAPCA currently is negotiating a contract for the develop-

ment of a conceptual design of a Rankine-cycle engine intended specifically for use in passenger cars.

Mr. KYROS. Do you have an adequate number of personnel to carry out the programs as of today?

Dr. MIDDLETON. Air pollution control has been a matter of importance to the Department of Health, Education, and Welfare for many years, since 1955.

With the enactment of the Clean Air Act and its amendments in 1967, there is a new thrust in which the States and local governments are obliged to undertake air pollution control.

In offering leadership, technical assistance and financial assistance, and in responding to the growing demand of the public for air pollution control, our present static employment situation does present problems. Our initial request of the House in the appropriation request for 1970 included a request for 138 positions, in addition to the 1,065 already authorized, and in the submission that we will make to the Senate, where hearings have not yet been held, we will be asking for 37 positions.

Mr. KYROS. Let me ask you, Dr. Middleton, are you doing any research on the internal combustion engine; for example, what about steam propulsion for motor vehicles?

Dr. MIDDLETON. We are doing some work with the improvement of the internal combustion engine, and we have a 5-year plan under development to do much more, not only with the improvement of the internal combustion engine, but perhaps more importantly, developing new propulsion systems.

Steam cars are fairly easy for the public to visualize and understand, but there are many other things that can be done in addition to steam. The Rankine cycle is an example, the steam engine being a part of that, and the use of other kinds of fluids and other kinds of condensing systems—all of these need to be looked at very critically, even the development of satisfactory electrical batteries for propulsion of cars.

So we have a stepwise program that looks at what can be done with the present car, but more importantly it is looking ahead, what is it we need to do by 1978 or 1980 by having a very clean car, because we don't expect to have this with the present improvements of the internal combustion engine.

This is the moment to have a considerable research and development program that is keyed to what other kinds of propulsion systems can be developed. If we do that work now, then when the time comes when we require it, we will be prepared.

If this is postponed, there is going to be another disparity and perhaps further increase in the air pollution levels. The present national standards for motor vehicles are bringing down the levels of pollution, but with the growth of the vehicle population and particularly the concentration in urban areas, the benefits of our 1970 and 1971 standards will be washed out.

So there is a real need to have a very significant program. The steam engine is one of these.

Mr. KYROS. What about the electrical propulsion? You said something about electrical batteries and you are studying methods?

Dr. MIDDLETON. This is an important research area. The present indications are that the use of electricity as a propulsion system for

our present kinds of cars is a further away achievement. That is not to say it is not an important priority, but we feel that there is much more likelihood of success in the Rankine cycle in the near future than there is with the battery system.

But to be assured that the Federal Government program is adequate, we think we must look at both.

Mr. KYROS. Has there been research into the possibility that if we do develop the electric cars, we will have problems with the generation of ozone?

Dr. MIDDLETON. There is always a possibility that ozone will be generated by electric systems. High tension lines carrying electricity contribute to this, but with the knowledge of making electric motors at this time and their driving systems this should be a very easily controlled item. I would say an electric car that was developed that produced ozone would be unsatisfactory, and that there would be emission regulations to see that the public was assured of having a clean car.

Mr. KYROS. How about the emissions from jet engines nowadays?

Is that a concern to you?

Dr. MIDDLETON. That is an important issue, and it has been a subject of study on our part. I would be pleased to present for the record a report on the jet aircraft pollution problem.

(For the information requested see appendix A, p. 41.)

Mr. KYROS. Is the incidence of such pollution higher perhaps in the Washington area than anywhere else? Or does this vary throughout the country?

Dr. MIDDLETON. Jet engines being what they are, and causing problems wherever they are, I would be remiss to say it is different in any of the large airports. I think what may be unique about National Airport is its proximity to the urban area, so that the impact is felt by the citizens living around the airport, and as it comes across the Potomac into the metropolitan area it is sensed by people in the District.

The smoke from jet aircraft can be controlled and we are looking forward to the aircraft industry doing something on their initiative to see that these emissions are reduced. In our report you will notice that they are taking steps in the direction of new sorts of combustion systems that reduce smoke.

We will see that this is programed on an understandable time basis and we will expect the industry to be responsive.

In the event that they are not, we will necessarily have some other recourse.

Mr. KYROS. I have seen a lot of articles recently, especially from, I think, the Department of Interior about foreign fuels coming to the United States with lower sulfur contents. Could you summarize for us the research that is going on concerning the removal of sulfur compounds from fuels before they are used?

Dr. MIDDLETON. We have a rather extensive program that deals with the removal of sulfur from fuels. We also have one that deals with the removal of sulfur from stack gas.

The effort is not of the dimension one would like to see, perhaps, but it is certainly in progress. We expected in 1970, based on our report on the need to control sulfur oxides and on the total research effort in the Federal establishment, that in the area of fuel desulfurization \$4.8 million would be spent in 1970.

We see the importance of fuel desulfurization and we are able to allocate \$4 million, so that that area is being fairly well attended. In other words, there is about \$0.8 million deficiency in a realistic program as we saw it.

We conduct and sponsor work to find where low sulfur oil and coal is presently located, and determine its availability and marketability, but perhaps more importantly, since low sulfur coal is used for a number of purposes aside from fuel, we are looking at ways of cleaning coals and removing the pyrites, as an example, from coals in a way that one obtains a clean coal, and the separated dirty coal is used to develop heat and energy and recover sulfur and other products.

In the case of oil, sulfur is being removed largely by the private sector, which has an interest in the erection of desulfurization plants where market demands suggest it to be appropriate. This is the general nature of our program of desulfurization of fuels.

Mr. KYROS. Dr. Carter, do you have any questions?

Mr. CARTER. What was your authorization for the past year?

Dr. MIDDLETON. Under section 104 it was \$90 million. Under section 309 it was \$134.3 million.

Mr. CARTER. What was the appropriation, if that was the authorization?

Dr. MIDDLETON. I will have to correct the record. Just a moment please. I am confused about 1969 and 1970 fiscal years, and you are asking for 1969, were you not?

Mr. CARTER. Yes, sir; of course section 104 runs out this year as we understand it and section 309 continues.

Dr. MIDDLETON. We asked for under section 309—

Mr. CARTER. I mean during the past year. I wanted to know how much was appropriated for last year under each section now. I asked first for the authorization and next the appropriation.

Mr. AUERBACH. The total appropriation for fiscal 1969 was \$88.7 million, of which \$18.7 million was appropriated under section 104 and the remainder under section 309.

Mr. CARTER. How much of the appropriation has been used or expended?

Dr. MIDDLETON. We expect to have it all expended except the money that we are carrying forward under section 104, which is being reserved for certain control pilot installations.

Mr. CARTER. The total was \$88 million. Now what results do you have from this, what have you found out with your \$88 million and what have you accomplished?

Dr. MIDDLETON. We found out a great deal, and I believe we have accomplished a number of things.

We have been able, for instance, to be assured that the motor vehicle emission restriction, I am talking about the practicality of air pollution control at this time, that control regulations applying to 1970 motor vehicles this fall will further reduce motor vehicle emissions.

We have also learned that the evaporative emissions from motor vehicles can be further reduced and we will have a national standard for this in 1971. We also have made sufficient progress in our research and development in fuels, in the desulfurization of fuels, in the sense that we know how to design now a deep coal cleaning process, and we are having one constructed which we expect to have in operation in

1971, at which time we will try 12 kinds of coals so that we may see this system run up to handling capacity of perhaps 500 to 1,000 tons per hour.

I think this as a rather specific achievement in the control area.

Mr. CARTER. How many people do you have employed at the present time?

Dr. MIDDLETON. Our ceiling is 1,065, but actual staff is diminishing in keeping with the Revenue and Expenditures Control Act.

Mr. CARTER. Where are your laboratories now, where you do your research, and where do you do most of it?

Dr. MIDDLETON. We are in the process of establishing a technical center for the National Air Pollution Administration in the Research Triangle of North Carolina. We presently have some of our research facilities there. We have established a laboratory in the State of Michigan which deals with motor vehicle control systems.

Mr. CARTER. Who has control of this laboratory? Do you have control of this laboratory?

Dr. MIDDLETON. Yes, sir.

Mr. CARTER. Do you staff it and so on?

Dr. MIDDLETON. Yes, sir.

Mr. CARTER. Do you work in conjunction with some group from Michigan or not? Do you do the complete staffing yourself?

Dr. MIDDLETON. The laboratory that we operate in the State of Michigan, presently at Willow Run in facilities that the Government leases from the University of Michigan, is staffed by the Air Pollution Control Administration. That is for the certification of motor vehicles for compliance with the national emission standards.

As you can see from this, we are in contact with the motor vehicle industry, and are able to learn in that kind of a liaison relationship research and developments as they take place.

Mr. CARTER. Your being close to them there would be helpful. Do you have it contiguous to any industry in North Carolina? I believe you said you were locating a facility there.

Dr. MIDDLETON. Our reason for going to North Carolina has been a decision of some years ago, and it is to primarily take advantage of the research facilities, the educational institutions there, and to also be in proximity with the National Institute of Environmental Health Sciences, so that our programs can be better related from the health viewpoint.

Mr. CARTER. You say you are doing some work on eliminating sulfur oxides?

Dr. MIDDLETON. Yes, sir.

Mr. CARTER. From what fuels particularly?

Dr. MIDDLETON. We have spent most of our efforts in the development of methods to clean coal, since the petroleum industry has rather clearly indicated that they, on their own initiative and their research programs, are coping with the desulfurization of fuel oils.

Mr. CARTER. What do you mean by that, the cleaning of coal?

Dr. MIDDLETON. Cleaning coal in the sense of taking the sulfur out.

Mr. CARTER. That is what I wanted to know.

Dr. MIDDLETON. This is the system whereby coals that contain pyrites of a cleanable size are processed and, if I may oversimplify the issue, and perhaps not satisfy the engineers at this point, by taking the

coal and separating the pyrites from the coal, one has a clean portion, and some coal left over with the dirty material, pyrites in this case.

Mr. CARTER. Sulfur is a component part of the pyrites, rather than the balance of the coal?

Dr. MIDDLETON. No; it occurs in two forms, pyrites and organic sulfur. Deep cleaning of coal does not remove the organic sulfur.

Mr. CARTER. What percentage of the sulfur oxides are removed by removing the pyrites?

Dr. MIDDLETON. In those coals in which the primary source of sulfur is the pyrites, you remove a large percentage, but if it is organic, you will not be able to remove the sulfur. It is for this reason that we have other programs for the removal of sulfur oxides from stack gases.

Mr. CARTER. What percentage of the Illinois coal—in Indiana, I believe it runs around 4 to 5 percent sulfur oxide. What percentage of the sulfur oxides from that coal have you been able to remove?

Dr. MIDDLETON. Through work with the transfer of funds from the Air Pollution Control Administration to the Bureau of Mines, and through the Illinois Geological Survey, a survey of Illinois coal is being made to find those coals that are amenable to sulfur removal.

Mr. CARTER. In other words, you don't know. You haven't found this out concerning coal in Illinois and Indiana?

Dr. MIDDLETON. May I ask Mr. Smith to respond to that?

Mr. SMITH. Our efforts are aimed at removing the sulfur from coal in two ways:

First of all, refining our knowledge of where cleanable coals exist, and then in a general way attacking the question of how can we improve the technology for cleaning of those coals which can be cleaned, so in one sense, rather than working on a specific coal, you work on methodology for the cleaning of pyrites from coal, by way of example, and some methodology for cleaning the organic sulfur from coal, and beyond this we are endeavoring to improve our knowledge of the location and nature of the existing coals that can be cleaned.

So if you have the technology, whether the coal were in fact in Illinois or some other State, if the technology is available, we would be able to bring forth the technology that could be applied at this time.

Mr. CARTER. And yet you have not gone far enough to determine what percentage of sulfur oxides you can remove from any given group of coals?

Mr. SMITH. You can presently talk about this once the coal has been classified in terms of its pyrite content and organic sulfur content.

We can remove some 40 to 70 percent of the pyritic sulfur. We have no good methods for removing the organic sulfur. In many instances, what this would mean, with coal of 2 percent sulfur, half of that being pyritic, you could reduce the total sulfur content of the coal down to the order of 1.3 percent sulfur from about 2.

Mr. CARTER. However, most of our coal is up about 4.9 percent, isn't it, sulfur oxide?

Mr. SMITH. There are quantities of coal in that range. There are substantial quantities of coal below 1 percent.

Mr. CARTER. It happens some of that coal is in my area in southeastern Kentucky.

Mr. SMITH. That is correct. It is.

Mr. CARTER. To use an acceptable level of oxides in coal to be burned in powerplants throughout our country—

Dr. MIDDLETON. I think we should point out to you that we are not establishing national standards for sulfur content of fuels. What we are attempting to do is make certain that the very considerable coal resources available in this country are extensively and properly used, so there is no anticipated limit of sulfur content of coal, but rather plans to assure that we can burn high sulfur coals and burn them well so that we don't have toxic levels of sulfur oxides in the outside air.

Mr. CARTER. Have you been able to accomplish this end?

Dr. MIDDLETON. We have not been able to achieve it at this time. We need a very considerable research and development program to do this. I think you would be interested in the coal conversion or the fuel conversion system, which is yet another way of taking care of the sulfur problem in high sulfur coal by making pipeline gas, or by converting coal to some other cleaner fuel.

So there are a number of ways in which the high sulfur coals can be effectively used in the national interest.

Mr. CARTER. Certainly we want to use this coal if we can, and we must think of eliminating the oxide at some place, whether it be after it is burned or before it is burned.

I believe someone spoke of cleaned coals being brought into the United States. Is that done to any extent or not?

Dr. MIDDLETON. The implication may have been there. It was in error if it was. I was talking about the importation of fuel oils.

Mr. CARTER. Insofar as coal is concerned, I believe in other countries it is much higher per ton in other countries than it is in the United States.

Dr. MIDDLETON. We do export low sulfur coals, of course, but we don't usually import them.

Mr. CARTER. Yes. We do export quite a bit. I was talking to the Bureau of Mines about that not too long ago.

Dr. MIDDLETON. We are quite anxious not to interfere with that exportation system.

Mr. CARTER. You touched on this, the use of coal and developing nuclear energy, or rather the use of nuclear energy to transform coal into gasoline and diesel fuel.

Has that been studied? Have you studied that very much? That is under study at the present time, the use of nuclear energy to transform, or use, coal to develop from the gasoline and diesel fuel and gases which could very well be used as sources of fuel with less residual oxides and other toxic products?

You are not familiar with that?

Dr. MIDDLETON. These schemes to have fuel converted are items that need much more attention than they are now receiving. I think it is very gratifying to see through the Department of Interior's Office of Coal Research, a coal gasification pilot system set up in the State of Illinois, in which the coals used are to be converted to pipeline gas. In this instance, the sulfur is removed in a way so that gas is supplied from dirty coal, if I can phrase it that way, and sulfur is recovered, so that an integrated system for seeing that sulfur oxides are removed from the air, sulfur is recovered, and yet a clean fuel is being developed.

Mr. CARTER. Yes; that is being done, and further study is being done at the present time, using as the source of energy—well, nuclear energy is the source of this.

Do you think that the millions of dollars which you have spent during the past year have accomplished their purpose? Have you gotten value for money spent?

Dr. MIDDLETON. I am convinced that we are stepping out strongly, forthrightly, and in the right direction. If we can continue to get the private sector excited enough to put their know-how and some of their cost sharing into this effort, I am sure the Government will derive more than just the dollars they put into it.

Mr. CARTER. And your appropriation last year was what?

Dr. MIDDLETON. \$88.73 million.

Mr. CARTER. It seems to me with that you could do considerable research yourself, even without involving the private sector.

Dr. MIDDLETON. We are doing considerable research.

Mr. CARTER. That is fine. We are interested in air pollution.

Dr. MIDDLETON. Our research effort is obviously impaired by the manpower which we are able to put into it, and therefore we are trying to capitalize on the private sector.

Mr. CARTER. Manpower is no small problem, and we look to a great deal of accomplishment with that sum of money. I am interested in reading your report on this. You have such a report, I guess; haven't you?

Dr. MIDDLETON. We have submitted a report for the record, and if there is additional information you would like to have, we will be glad to submit it. (See p. 6.)

Mr. CARTER. Thank you kindly.

Thank you, Mr. Chairman.

Mr. ROGERS (presiding). Mr. Kyros?

Mr. KYROS. Thank you.

Do you coordinate your activities with the solid waste disposal program in any way?

Dr. MIDDLETON. Yes, we do.

The solid waste program is a part of the Environmental Control Administration, and we are the National Air Pollution Control Administration, of course, and each of us is part of the Consumer Protection and Environmental Health Service.

So there is in the Office of the Administrator the necessary arrangements to assure coordination.

More specifically, I can tell you that through Dr. Ludwig, a member of my staff, and Mr. Smith, who is before you this morning, and the Bureau of Solid Waste Management, we are developing jointly a 5-year research and development plan that truly is coordinated, from their sense of how one takes care of disposal, and from our sense of how one does it in a clean way.

Mr. KYROS. In other words, if you develop new kinds of incineration, the emission will be controlled?

Dr. MIDDLETON. Not only will we assure that incinerators are improved, but it is our hope that there will be fewer and fewer incinerators and better ways of disposing of solid waste.

The air pollution problem is primarily a combustion problem, and one has to think of solid waste as a fuel, and it is often disposed of in poor ways, so it becomes a pollutant instead of a source of energy.

The rule of thumb is, "Don't burn unless you have to."

Mr. KYROS. You can't dig a hole in the ground, so what else are you going to do?

Dr. MIDDLETON. I am not suggesting one supplant the other, but that there be an approach that gives consideration to the container vessels themselves.

Mr. KYROS. What about the coordination of your activities with the water quality program? Is that also in the same analogy as you just described?

Dr. MIDDLETON. We have some water quality programs within the Consumer Protection and Environmental Health Service. We have the same kind of relationships with the Office of the Administrator.

We are presently conducting a joint study, for example, in the State of Montana, assisting the State of Montana in making a study of the possible impact of smelter effluents on health and welfare. Not only is air pollution concerned in this instance, but the Environmental Control Administration and the Food and Drug Administration.

I think these are good examples of how coordination can take place within the Consumer Protection and Environmental Health Service.

Mr. KYROS. In regard to some of the moneys you have spent, Dr. Middleton, I think you indicated you had joint study programs going on with States, and that you provide matching moneys to States for programs. Is that right?

Mr. SMITH. Yes, we do provide matching funds to State and local agencies also.

Mr. KYROS. How many States have been involved so far? Have all 50 States been involved in this matching fund program? If you don't know, sir, you can supply it for the record.

Dr. MIDDLETON. Almost all have been concerned as far as air pollution control is concerned.

Mr. KYROS. Thank you very much.

Thank you, Mr. Chairman.

Mr. ROGERS. Mr. Hastings?

Mr. HASTINGS. I have no questions.

Mr. ROGERS. It is good to see you, and I apologize for being late. I had a speaking engagement.

I have read your statement, and I understand that a number of questions I was going to ask have already been asked.

What have you done to stop air pollution by Federal facilities in Washington, D.C.?

Dr. MIDDLETON. Through the interest of the Congress and on the part of the President, we initiated an air pollution abatement conference. This conference was held, recommendations were made on the part of the conferees, the Secretary adopted these recommendations, and they are now in the process of being implemented.

Further, the National Capital Interstate Air Quality Control Region was the first region designated, Mr. Rogers, and the States of Virginia, Maryland, and the District of Columbia are now in the difficult, but important, process of developing air quality standards.

I am happy to report that the Governors of the two States and the Commissioner-Mayor of the District have stated positively their intent to develop standards.

Mr. ROGERS. What is the time element on that?

Dr. MIDDLETON. The starting date was the issuance of the criteria in February 1969, so within 15 months of that time we would expect to have, if everything comes out well, standards adopted, the implementation plan adopted if approved by the Secretary, so that the three parties involved would be expected to carry out their program 15 months from the criteria date.

We would expect the Federal facilities to meet all the requirements that are needed to reach the air quality in the control region.

Mr. ROGERS. Have we already set any standards for our Federal installations? Have we done that?

Dr. MIDDLETON. We have set emission restrictions for sulfur oxides for the three metropolitan areas of Chicago, New York, and Philadelphia. This program is underway.

Mr. ROGERS. Is there any reason why we can't do that within our own facilities when we know what emission standards should be anyhow?

Dr. MIDDLETON. There is much to be said, Mr. Rogers, for having an integrated approach so that—

Mr. ROGERS. I understand that.

What I want to know is, we know that Federal installations here in the city of Washington are contributing to the air pollution problem.

Dr. MIDDLETON. That is true, very importantly contributing a portion.

Mr. ROGERS. If we have the present knowledge, a simple order by the Government or the President or the various departments, I would think initiated by your office, could bring about an adherence to certain standards in Federal installations here.

Could that be done now?

Mr. AUERBACH. Mr. Rogers, following the conference in December 1967, at which recommendations were made for control of sulfur oxide pollution from Federal facilities, this action has been taken, and has been reported to the Congress.

Briefly, since November 1967, all fuel oil procured for Department of Defense facilities in the Washington area by the General Services Administration has contained a maximum of 2 percent sulfur.

For the 1968-69 heating season, fuels have had 1.5 percent sulfur, and for the 1969-70 heating season, it is expected that 1 percent sulfur fuel will be provided for Department of Defense facilities in the area.

Additionally, for other departments and agencies, progress has been made in securing lower sulfur fuels for use in the Washington area. This is explained in some detail here, which we can submit for the record, of course.

Mr. ROGERS. That will be fine if you will submit it.

(The document requested is Senate Document No. 91-10, "Air Pollution Abatement by Federal Facilities," Second Report of the Secretary of Health, Education, and Welfare, to the U.S. Congress pursuant to Public Law 90-148, the Air Quality Act of 1967. See p. 81.)

Mr. ROGERS. But what I want to know is, What is the emission level that you approve?

Mr. AUERBACH. The recommendations for the Washington, D.C. area I do not have in front of me, but I believe that with regard to sulfur oxide levels in the air, they were in accord with the air quality criteria we have published.

Mr. ROGERS. Is it 1, 1.5, or 2?

Dr. MIDDLETON. I feel it necessary here to refer to the earlier comment, Mr. Rogers, about an integrated approach.

In the sense that the air quality standard that is to be met, some number, perhaps 300 micrograms per cubic meter, can be met only if all the sulfur-emitting facilities have some emission regulation.

The extent to which they should be regulated depends upon having a proper diffusion model made so that you can predictably say what the restriction should be.

An emission reduction of 1 percent sulfur-containing fuel may be insufficient to meet the desired air quality level, so rather than have a single emission regulation for all facilities, it is very likely that the implementation plan will require still further reductions which may be better achieved through stack gas cleaning or some other method.

It is for this reason that we have not promulgated at this time emission regulations because the several States shall have to consider this as a part of their implementation plan together with their standards.

Mr. ROGERS. I understand that, and this is desirable, but I don't know that that is any reason for the Federal Government not to go in and do what it can now.

If you put a minimum standard or a maximum standard, it is true that when they make the areawide or regional airshed standard, which takes into consideration everything that is going into that airshed, they may have to reduce what the standard is, say from 1, in 1970.

But if it ought to be, say, a half now, why can't we go ahead and make that correction without waiting 2 or 3 years to wait until this area quality standard is set?

Dr. MIDDLETON. The material Mr. Auerbach gave you represents what seems to be feasible—

Mr. ROGERS. This is what I want to know.

Is this proper?

Dr. MIDDLETON. This is a proper rate at this time. It seems to be as much as can be requested based on the availability of fuels, and it is likely to be inadequate, and more stringent systems will have to be developed.

Our program is designed to see what those are and how they can be implemented.

I think we have gone about as far as we can with our available technology.

Mr. ROGERS. I thought you had set them in New York and Philadelphia. Is it difficult to set them in Washington?

Mr. AUERBACH. That is what these numbers represent, sir.

Mr. ROGERS. Is this what you have set in New York and Philadelphia, the same standards?

Mr. AUERBACH. The standards for Federal facilities in New York, Chicago, and Philadelphia would require the use of somewhat lower content fuel, because in those areas the multiplicity of sources requires that fuel burning sources all use fuel containing less sulfur than in Washington.

Those areas have a greater number of installations.

Mr. ROGERS. I understand that.

So you have set lower standards in New York, Chicago, and Philadelphia.

Mr. AUERBACH. Yes.

Mr. ROGERS. If they can get the fuels, why can't the Defense Department get them here?

Mr. AUERBACH. The needs for the low sulfur fuels—

Mr. ROGERS. I think you missed the thrust of my question.

I said if those businesses in New York and Philadelphia can acquire the fuels to meet the lower standard, why can't the Defense Department also acquire fuels to meet a lower standard?

Can they?

Mr. AUERBACH. The ability to acquire lower sulfur fuels depends, of course, in part on the price you have to pay and the price you have to pay depends on how badly you need it.

Now, the need is greater in New York, Chicago, and Philadelphia.

Mr. ROGERS. In other words, they are available, but the notice becomes a matter of cost? Is that what you are telling me?

Mr. AUERBACH. Cost is a factor in obtaining low sulfur fuels, fuels naturally low in sulfur.

Mr. ROGERS. Maybe we ought to go into this more, and see how much of the budget is being devoted to this, and see whether we think it is worth the cost to pollute our air here in Washington.

This is basically what you are saying.

Mr. AUERBACH. The estimates for the relationship between emissions and air quality in Washington indicate that at the present fuel containing a maximum of 1 percent sulfur would be satisfactory.

Mr. ROGERS. But they have not reached that yet.

Mr. AUERBACH. For the 1969-70 heating season, they will reach 1 percent. That is this fall.

Mr. ROGERS. What about all the other governmental installations in Washington. Are they meeting the same, or higher?

Mr. AUERBACH. The General Services Administration has reported that all major coal-burning steamplants are burning coal of 1 percent sulfur or less.

Mr. ROGERS. Did GSA do all of the purchasing?

Mr. AUERBACH. GSA does the majority of it. There are more details in this report. There are some specific examples in here.

Mr. ROGERS. Which ones are not?

Mr. AUERBACH. Offhand, I don't know whether any are not.

Dr. MIDDLETON. Could we develop them and supply them, Mr. Rogers?

Mr. ROGERS. Yes.

(The following information was received for the record:)

NATIONAL AIR POLLUTION CONTROL ADMINISTRATION ON STATUS OF AIR POLLUTION ABATEMENT BY FEDERAL FACILITIES IN THE NATIONAL CAPITAL AREA

Up-to-date information on the status of air pollution abatement by Federal facilities in the National Capital area: Federal departments and agencies are required to submit periodic reports to the Bureau of the Budget on progress in abatement of air pollution. These reports are due annually on July 1. The Bureau of the Budget forwards copies of these reports to the National Air Pollution Control Administration. After these reports have been received and evaluated, we will be pleased to furnish the Committee the requested information.

Mr. ROGERS. Offhand, would you know?

Dr. MIDDLETON. The Department of Defense, using fuel oil, we will be sure that no agency will be burning oil of more than 1 percent sulfur.

Mr. ROGERS. What about Chicago, Philadelphia, and New York?

Dr. MIDDLETON. The standards are different there.

Mr. ROGERS. What are they?

Dr. MIDDLETON. The requirements in New York are presently being met at 1, but there is a time when the fuel is supposed to be 0.3 or equivalent in emission.

Mr. ROGERS. When is that?

Dr. MIDDLETON. 1971. They have until that time to get that low.

Mr. ROGERS. What about Chicago? Or Philadelphia, if you don't recall Chicago.

Dr. MIDDLETON. I regret that I did not bring that material with me.

Mr. ROGERS. I realize you may not remember every detail.

Dr. MIDDLETON. Chicago and New York are the same, but Philadelphia may not be as low.

Mr. ROGERS. Are there other cities in this program?

Dr. MIDDLETON. The philosophies developed in other cities is that they shall be as good as local and State requirements. The Federal facility will have to comply with that as every other combustion system.

Mr. ROGERS. How far are we from getting compliance, would you say, in the country?

Dr. MIDDLETON. Compliance in the area where coal is primarily a fuel will be further off, perhaps, than oil.

Mr. ROGERS. How many years, would you say?

Dr. MIDDLETON. In the research program that we discussed superficially here this morning, we would expect this to be achieved in 5 years in large measure.

That is, the deep coal cleaning, we would expect to have the design completed this year. We would expect to have a pilot plant built in 1970. We would expect to have the result, certainly, in 1971, and the way we are designing this, we would expect the scale up to be very simple from that.

This gives you some idea of the practicality of this program.

Mr. ROGERS. As I understood from an earlier question, you don't have sufficient personnel to do this work.

Dr. MIDDLETON. We do not. We are counting rather heavily on the private sector. It is very often necessary to give them some assistance to get them started.

Mr. ROGERS. What is your actual shortage of personnel, do you feel, to carry on this type of program?

Dr. MIDDLETON. In my professional opinion, the request of 138 in the initial House request was a step in the right direction. Earlier budgets talked about much more than that.

Mr. ROGERS. Yes.

I want your professional judgment on the number of personnel that you need, that you are short right now, to carry on an adequate program.

Dr. MIDDLETON. At this time, our program would be able to meet some of the real requirements of the State and local governments as

well as some of our own research needs if we had 1,500 to 1,600 people as a present estimate.

We need about 500 more than we now have.

Mr. ROGERS. You are 500 short.

Mr. AUERBACH. 1,065 is the present ceiling. We are somewhat under that, because of the requirements of the Revenues and Expenditures Control Act.

Mr. ROGERS. When this program was set up in 1955, how many personnel did you have, about?

1956, I guess it would be.

Dr. MIDDLETON. 1955 was the enabling act. I am not sure that any of us have been here long enough, Mr. Rogers, to know. That could be discovered, however.

Mr. ROGERS. When did you have your main reduction in personnel?

Dr. MIDDLETON. The request for personnel that the former Division of Air Pollution, and then the National Center for Air Pollution Control, and now the National Air Pollution Control Administration, their requests have been acceded to on the part of Congress until the Revenues and Expenditures Control Act.

Mr. ROGERS. I understand the budget requests are the same from the prior administration and this administration?

Dr. MIDDLETON. They are.

Mr. ROGERS. And you will devote \$18 million of that budget to this program?

Dr. MIDDLETON. That will be devoted to the research and development aspects.

Mr. ROGERS. How many contracts do you have in being?

Dr. MIDDLETON. We are collaborating with at least 70 organizations. I can supply for the record the precise number.

Mr. ROGERS. We would like to know what areas of research they are in, and how much intramural research you are doing.

(For the information requested see appendix B, p. 81.)

Mr. ROGERS. Can you give me that off the top of your head?

Dr. MIDDLETON. We estimate about \$10 million within our organization, and about 100 people.

Mr. ROGERS. In your intramural research?

Dr. MIDDLETON. Yes.

Mr. AUERBACH. We have research and development which is conducted with section 104 funds, plus some of the funds appropriated under section 309.

Mr. ROGERS. What is the total of funds under both?

Mr. AUERBACH. In 1969, it is \$88,738,000, under both sections. I believe, of that, about \$42 million, totally, is for research and development, of which \$18 million, is section 104.

Dr. MIDDLETON. I could clarify this in general by saying that in the research and development and demonstration area this year, 1969, \$45.6 million is the amount, which involves 548 people.

Of that, \$20.9 million is direct operations, and that is within the organization; \$24.7 million is without the organization, and the section 104 is about \$18.7 million of that.

Mr. ROGERS. Section 104 is \$18 million?

Dr. MIDDLETON. About \$18.7 million.

Mr. ROGERS. What is the distinguishing feature between sections 309 and 104, just quickly?

Dr. MIDDLETON. Section 104 money is no-year money. It gives explicit discretion to the Secretary for the disposal of property developed on private lands. It clearly accents the part and the role the Congress expects the private sector to play with Government in developing the control technique required.

Mr. ROGERS. So about half of your budget is going into research under section 104.

Dr. MIDDLETON. Yes.

The other parts of our research include the air quality criteria. What pollution should we be concerned with, in what sequence, and so forth?

Mr. ROGERS. I would like a rundown, too, on the section 309 funds.

Dr. MIDDLETON. In the research area?

Mr. ROGERS. Yes; in the research and demonstration area, and who is involved, and what projects are being done, and the number of people and amount of funding.

Dr. MIDDLETON. We will supply that for you.

(For the information requested see appendix C, p. 113.)

Mr. ROGERS. What are you doing about bus emissions? Have you done anything? Is any progress being made? If you get behind these big buses, the pollution and fumes are overwhelming.

Dr. MIDDLETON. I am with you.

Mr. ROGERS. What ought to be done? Not much has been done yet.

Dr. MIDDLETON. The Federal Government is requiring emission regulations of diesel trucks and buses for the first time this year. We are having requirements for gasoline-powered trucks and buses as of this year. So that there is the first step in this direction.

Mr. ROGERS. In other words, the new buses that came out this year?

Dr. MIDDLETON. The new buses that come out this year—January 1, 1970—we will have these regulations. Nothing required until the beginning of this next year, and that will be the first step in controlling smoke emissions.

Mr. ROGERS. How much of a reduction will there be?

Dr. MIDDLETON. We expect a significant reduction in the smoke aspect from the new diesel engines. The gasoline-powered trucks and buses will have the same degree of control that is now being conducted in the State of California.

We are not controlling odor from diesel buses. We have a program to determine what this is and what can be done about it. When we know this, we will do something about it.

Further, we are developing, Mr. Rogers, a system that will tell operators of existing diesel trucks and buses what they can do to improve the performance of those vehicles.

We expect to do this through an instructional program with the Federal agencies to begin with, and hopefully the States may become interested and adopt it themselves.

Because there is very little need to have smoke from existing diesels.

Mr. ROGERS. Is there any difference in emissions from the two-cycle and four-cycle?

Mr. SMITH. There is a difference. I can't give you the details of it. I know that there is also a very serious questions of diesel control between the two-cycle and the four-cycle.

Mr. ROGERS. Let us have something on that for the record.

(The following information was received for the record:)

TWO-CYCLE AND FOUR-CYCLE DIESEL ENGINE EMISSIONS

Two types of diesel engines are in common use in the United States, i.e., two cycle "blown" engine and the four-cycle, either naturally aspirated or blown. In general, the two-cycle engine is used predominantly for intracity bus application, while the four-cycle engine is used on both intercity and intracity truck operation. Both types are significant sources of smoke and odors, not only in urban areas, but also along heavily travelled rural highways.

The two types of engines, i.e., two-cycle and four-cycle engines, have inherently different emission characteristics, due fundamentally to the differences between the time-temperature relationships in the combustion processes of the two engine types. In the two-cycle engine, the blast of cold scavenging air induced into the cylinder at the end of the power stroke dilutes the gases and thus quenches the combustion reaction. In the four-cycle engine, the combustion reaction at the end of the power stroke has an additional 180° of crank shaft rotation for the completion of the oxidation reaction prior to discharge through the exhaust system of the engine. Thus, the unreacted hydrocarbons, smoke and, odors that might otherwise appear in the exhaust have some additional time for combustion.

Despite the fundamental differences in the combustion processes between the two engine types, the same control approaches for smoke, odor, and gaseous hydrocarbon, carbon monoxide, and oxides of nitrogen are applicable to both. The approach taken by all manufacturers to date, which is thought to offer the highest probability of success in effecting significant reductions in smoke and odor as well as reductions in gaseous emissions, is that of engine refinement based on detailed studies of the engine operating variables. Since diesel engines develop more power when operated at excessively high fuel ratios, with the subsequent increase in smoke, some derating from maximum power is necessary to limit smoke and odor intensities. Additional gains can be obtained through further engine derating, at the expense, however, of engine power output and some increase in fuel consumption. Further, modifications of the combustion chamber design itself, together with improvements in injector spray patterns and prevention of injector dribble, offer promise of further reductions in smoke and odor as well as gaseous emissions.

Another approach under investigation, which offers less potential of success, lies in the area of fuel composition and additives. Generally, less volatile, highly cracked aromatic fuels tend to produce higher smoke and, in many cases, odor levels, as well. Thus, tighter control of fuel specification can produce reductions in emission levels. Efforts in this area is primarily directed toward optimizing production of uniform quality fuels, together with the inclusion of detergent-dispersant additives to minimize troublesome injector deposits. While it is not anticipated that fuel improvements and additives alone can produce significantly lower smoke and odor emission levels, the incremental gain and reduced service deterioration resulting from this approach are important contributors to the reduction of smoke and odor levels.

Other control approaches including catalytic oxidation, exhaust gas recirculation, etc., are not at a stage of technical development at which they offer immediate or near-future solutions to the problem.

National standards for the control of smoke from diesel engines have been established by the Department of Health, Education, and Welfare. These standards will apply to all new diesel engines manufactured on or after January 1, 1970, for use in heavy duty vehicles (more than 6,000 pounds gross vehicle weight). The standards limit the opacity of smoke emissions to forty percent during engine acceleration and twenty percent during engine lugging, as measured by procedures set forth in regulations published in the *Federal Register* on June 4, 1968.

Mr. ROGERS. On page 3, you say: "A more modest program relating to motor vehicle emission control is also being conducted under section 104."

What is the import of that statement, that you are having a modest program concerning motor vehicle emission control?

Dr. MIDDLETON. Rather than have none, we have this. We are trying to get a good plan for a 5-year base established, and then get it properly funded.

Mr. ROGERS. How much in funds are you contributing to that?

Dr. MIDDLETON. \$650,000.

Mr. ROGERS. Out of \$45 million?

Dr. MIDDLETON. For the development of low-propulsion systems.

Mr. AUERBACH. The total amount of motor vehicle research activity in fiscal 1969 is about \$4 million.

Mr. ROGERS. I don't understand why you are not devoting greater effort here, when my understanding is that the statistics say that motor vehicle pollution amounts to about 60 percent of the problem. Is that true?

Dr. MIDDLETON. Let me offer this counsel, and perhaps it can be considered an explanation.

The Federal Government now regulates the gasoline-powered motor vehicle. We will regulate the truck and bus, and diesel. The regulations that are now in effect, and those proposed for 1970 and 1971, will bring down motor vehicle pollution to a much lower level in the 1967-80 period.

Then, Mr. Rogers, at that time, the emissions from the motor vehicle will begin to rise again unless there is a more stringent control of the motor vehicle, or unless there are new ways of controlling and developing power systems.

It is in this interval that we are now developing, with the \$650,000, a program designed for new propulsion systems.

Mr. ROGERS. What is this, steam?

Dr. MIDDLETON. The expected need for replacement of the internal combustion engine with Rankine cycle or steam and electric cars. If we start now, when we arrive at 1978 to 1980, we will have something in hand that can be used as a substitute propulsion system.

That is why the money is relatively higher in allocation to the sulfur oxides problem for which there is very little control technology.

We have some considerable control in motor vehicles today, so we are looking forward to generating a stronger program for motor vehicle control in future years.

Mr. ROGERS. Do you help set standards for motor vehicle emission?

Dr. MIDDLETON. We do. The authority for establishing those is with the Secretary of Health, Education, and Welfare.

Mr. ROGERS. It is my understanding that present emission standards will not stabilize, much less reduce particular air pollution. Is that a correct statement?

Dr. MIDDLETON. There is a downward trend, and this trend will continue until about 1978, at which time it will go up. This is the response—

Mr. ROGERS. Under existing controls, automobile air pollution in the United States will more than double in the next 30 years because

of the projected increase in the number of vehicles and the miles driven by each vehicle.

Would that be so?

Dr. MIDDLETON. That is so.

Mr. ROGERS. In the present emission standards, the oxides and photo-emission will be higher than if no standards existed.

Dr. MIDDLETON. That is correct.

Mr. ROGERS. Only California has adopted emission standards for the 1970's which will control the oxide of nitrogen. Is that correct?

Dr. MIDDLETON. They have initiated that program.

Mr. ROGERS. But there is no guarantee that the automotive industry will produce cars that will meet those standards?

Dr. MIDDLETON. There is no guarantee. The plans for different kinds of propulsion systems is how we expect to keep the pressure on so that the research and development will go forward as quickly as possible.

Mr. ROGERS. I don't understand that if 60 percent of the problem in air pollution is the automobile, that we have not yet set standards that will really have much effect.

We are only devoting at the most about \$4 million of your budget to 60 percent of the problem.

Now, why is that?

Dr. MIDDLETON. Within the budget limitations and the importance—

Mr. ROGERS. Now, wait. You have \$45 million in the budget, I understand. Is it \$88 million, or \$45 million?

Dr. MIDDLETON. The total budget is \$88.773 million. The total budget for this area is \$45.61 million.

Mr. ROGERS. How much of the \$88 million budget is going to automobile emission problems, the \$4 million?

Dr. MIDDLETON. The \$4 million is for the motor vehicle program, both the new propulsion systems and the other motor vehicle research and development activities.

Mr. ROGERS. So out of \$88 million, you are spending \$4 million on 60 percent of the problem?

Dr. MIDDLETON. It is a very inadequate budget.

Mr. ROGERS. It is a very inadequate division of the budget.

Is this the judgment of Congress that you should only spend \$4 million, or the Department's?

Dr. MIDDLETON. It is the Air Pollution Control Administration's judgment.

Mr. ROGERS. How do you justify the expenditure of only \$3 million out of \$88 million?

Dr. MIDDLETON. We have difficulty in justifying that in view of the problem you have accented and the figures you have given regarding the upcoming seriousness of the problem, but we have no beginnings, essentially, for sulfur oxide control and so forth, and these are also hazards to health.

So where you have nothing—that is a relatively free use of the word—relatively little for sulfur oxide control, and really no sizable program going, it is very important that this get started at a sizable level, because we do have a way of coping with the motor vehicle problem for these few years.

Mr. ROGERS. But you admit it is inadequate.

Dr. MIDDLETON. Within the total funding for the Administration.

Mr. ROGERS. What we have said we have done is inadequate as far as meeting the emission problem of automobiles and trucks and buses. Is that right?

Dr. MIDDLETON. We are in the process of rolling the emissions back. We do have something going for us in a downward trend in the motor vehicle. While the downward trend is going on, Mr. Rogers, we are trying to pick up the other kinds of pollution that are becoming relatively more important.

Mr. ROGERS. But you admit that the present emission standards will not stabilize, much less reduce, vehicular air pollution, and also that the present emission standards, the oxides of nitrogen will be higher than they would be if no standard existed.

Dr. MIDDLETON. I do not contest that information at all. It is correct.

Mr. ROGERS. Then I am at a loss to understand why you will devote 3.4 percent of your budget to this problem and 96.6 percent to other problems.

Why would you divide it that way?

Why wouldn't you devote at least 60 percent to the emission problem? That is what is causing us the trouble.

Dr. MIDDLETON. Your questions are certainly the kind I would like to respond to, and I hope I can respond clearly.

The air pollution control effort on the part of the Federal Government is a minimal effort. It should be much more than it has been. There are so many things that need to be caught up with that we have to be rather arbitrary.

In this case, the \$4 million is a particularly sensitive point. In seeing that those things that need to be done in protecting health from oxides of nitrogen, and many other pollutants that we will be developing criteria for that we have already announced, we have to have a sizable part of our research and development budget, Mr. Rogers, dedicated to seeing to it that there is a response to the need for control techniques for other pollutants during the period of years when the motor vehicle is being attended to, in a way.

At the same time, we develop a research and development program that will catch up to the rollback and then move swiftly forward.

Mr. ROGERS. I understand your reasoning. I must say that I know you want to do things where there has been nothing done, but 60 percent of the problem, which is a major problem, is not being met, and California has set standards, and we don't know whether the industry can or will do it.

Can they do it?

Dr. MIDDLETON. I would hope they would try to.

Mr. ROGERS. Is it feasible?

Dr. MIDDLETON. I think they can be met.

Mr. ROGERS. I don't know why we have Federal standards and not make sure they are met.

Dr. MIDDLETON. We have Federal standards——

Mr. ROGERS. Let us not get into semantics here. I know you have some standards that are going to do a little something, but your standards are not even as strong as California's now, and we admit our standards won't meet the problem.

You said that California's would, but we don't know if industry will do it.

Wouldn't it be encouraging to the industry if you immediately set standards that matched California's to meet the problem? Wouldn't this be added incentive for industry to meet these improvements?

Dr. MIDDLETON. In direct reply to your question, I say, yes, it would be an additional incentive to the industry.

The waiver of the standards in the State of California by the Secretary of Health, Education, and Welfare, was to provide California, in the case of their pressing problem, an opportunity to do something more about it.

This gives a trial period to see what success there is and will enable better understanding of the national applicability.

Mr. ROGERS. Well, if the industry is not going to do it, they are not going to have much success in trying to prove it out, are they?

Dr. MIDDLETON. We are in the process of developing a mass emission standard. This will probably be published in the Federal Register this fall. This will be another step in the direction of having more stringent controls on the part of the Federal Government.

Mr. ROGERS. How soon will they be published?

Dr. MIDDLETON. This fall.

I believe in September.

Mr. ROGERS. Would you keep the committee advised on this?

Dr. MIDDLETON. I certainly will.

Mr. AUERBACH. Mr. Rogers, perhaps I can clarify this. There are now in effect national standards for motor emission control, applying to carbon monoxide and hydrocarbons.

Beginning with the 1970 model year, more stringent standards will take effect. These standards will produce a downward trend of carbon monoxide and hydrocarbon emissions that will last for the next 5 to 8 years.

After that period, admittedly, without further controls, the trend will go back upward again, but there are standards in effect which are now producing a downward trend, and in this interim period there is the opportunity to conduct further research to try to develop means of—

Mr. ROGERS. This is the point I am saying.

Mr. AUERBACH. I would not disagree with your basic point on the relationship of the size of the problem to the size of the research and development effort.

Mr. ROGERS. I hope you will look at this again, because the committee is going to be interested in following this closely. Something has to be done about this, if we are devoting only 3.4 percent of the budget to 60 percent of the problem. I think you ought to look at this.

We have to accelerate this research. That is why the Congress did this. We knew the problem was 60 percent of the pollution problem of this Nation, and we are not responding, and we really need to put accent on this, and get something moving.

We are not even doing as much as California.

Let me ask you this, now, to supply for the record.

I have gone much further in my time than I should have. I want to know the number of airsheds that have been formed, their status, how many more are anticipated, when will we have all of the airsheds,

when standards will be set, and when we may expect enforcement to begin.

If you will, let us have that for the record.

Dr. MIDDLETON. That material is available, and we will be pleased to supply it.

(The following information was received for the record:)

IMPLEMENTING THE REGIONAL AIR POLLUTION CONTROL MECHANISM ESTABLISHED BY THE AIR QUALITY ACT

The Air Quality Act of 1967 (Public Law 90-148) provided for an intergovernmental system for the prevention and control of air pollution on a regional basis. To put this system into operation, the Department of Health, Education, and Welfare must designate air quality control regions and issue air quality criteria and reports on control techniques. State governments then are expected to establish air quality standards for the air quality control regions and to adopt plans for implementation of the standards. *Guidelines for the Development of Air Quality Standards and Implementation Plans* has been issued to assist the States in carrying out their responsibilities. A copy of this document is attached. The air quality standards and implementation plans adopted by the States must be submitted to the Department for review.

The National Air Pollution Control Administration has identified 57 metropolitan areas where air quality control regions are scheduled to be designated by the summer of 1970. Each State will have at least a portion of one air quality control region within its borders. To date, the Secretary has designated 13 regions and the National Air Pollution Control Administration officials have held consultations with State and local officials in five proposed regions.

Air quality criteria were issued February 11, 1969, for sulfur oxides and particulate matter—two of the most common types of urban air pollutants. Reports on control techniques applicable to the sources of these pollutants were issued at the same time. Next year, it is expected that criteria will be issued for carbon monoxide, photoreactive organic compounds, and oxidants. Plans for 1971 and subsequent years involve issuance of criteria for nitrogen oxides and a number of other pollutants. The pollutants under consideration include arsenic, asbestos, beryllium, cadmium, fluorides, lead, odorous compounds, organic carcinogens, pesticides, and pollens-aeroallergens.

The attached table summarizes the status of air quality control region designations and the timetable for State action.

TABLE 1.—AIR QUALITY CONTROL REGIONS DESIGNATED BY THE SECRETARY

Region	Date of designation	Area of the region	(sulfur oxides ₂) and particulate timetable	
			Standards ¹	Plans ²
National Capital.....		District of Columbia; 2 counties in Maryland; 4 Nov. 11, 1969		May 11, 1970
New York.....	Nov. 20, 1968	4 counties in Virginia; 3 cities in Virginia. 8 counties in New York; 9 counties in New Jersey; part of Fairfield County in Connecticut.	do.....	Do.
Chicago.....	Dec. 4, 1968	6 counties in Illinois; 2 counties in Indiana	do.....	Do.
Philadelphia.....	Dec. 17, 1968	5 counties in Pennsylvania; 5 counties in New Jersey; 1 county in Delaware.	do.....	Do.
Denver.....	Jan. 15, 1969	All of 3 counties and parts of 3 other counties in Colorado.	do.....	Do.
Los Angeles.....	Jan. 29, 1969	All of 2 counties and parts of 4 other counties in California.	do.....	Do.
St. Louis.....	Apr. 11, 1969	2 cities and 2 counties in Missouri; 3 counties in Illinois.	Jan. 11, 1970	July 11, 1970
Boston.....	Apr. 12, 1969	98 cities and towns in Massachusetts.....	Jan. 12, 1970	July 12, 1970
San Francisco.....	May 1, 1969	9 counties in California.....	Feb. 1, 1970	Aug. 1, 1970
Pittsburgh.....	do.....	7 counties in Pennsylvania.....	do.....	Do.
Buffalo.....	do.....	2 counties in New York.....	do.....	Do.
Cincinnati.....	May 2, 1969	4 counties in Ohio; 3 counties in Kentucky; 2 counties in Indiana.	Feb. 2, 1970	Aug. 2, 1970
Cleveland.....	May 23, 1969	8 counties in Ohio.....	Feb. 23, 1970	Aug. 23, 1970

¹ Approximate date by which air quality standards for sulfur oxides (SO₂) and particulate matter must be established by the States involved.

² Approximate date by which implementation plans for sulfur oxides (SO₂) and particulate matter standards must be established by the States involved.

TABLE 2.—AIR QUALITY CONTROL REGIONS IN THE CONSULTATION STAGE

Proposed regions	Date of consultation	Proposed region
Kansas City.....	Apr. 11, 1969	5 counties in Missouri and 4 counties in Kansas.
Hartford-Springfield.....	Apr. 29, 1969	44 cities and towns in Connecticut and 43 cities and towns in Massachusetts.
Minneapolis-St. Paul.....	May 21, 1969	7 counties in Minnesota.
Baltimore.....	May 23, 1969	1 city and 4 counties in Maryland.
Indianapolis.....	June 10, 1969	8 counties in Indiana.

TABLE 3.—Air Quality Control Regions Scheduled for Designation by the Summer of 1970

REGION	
Detroit	Oklahoma City
Milwaukee	Omaha
Providence	Honolulu
Seattle-Tacoma	Beaumont-Port Arthur
Louisville	Charlotte, N.C.
Dayton	Portland, Me.
Phoenix	Albuquerque
Houston	Lawrence-Lowell-Manchester
Dallas-Fort Worth	El Paso
San Antonio	Las Vegas
Birmingham	Fargo-Moorhead
Toledo	Boise
Steubenville	Billings
Chattanooga	Sioux Falls
Atlanta	Cheyenne
Memphis	Anchorage
Portland, Oreg.	Burlington
Salt Lake City	San Juan
New Orleans	Virgin Islands
Miami	

Mr. ROGERS. I am not trying to belittle what you have done. I know of your great interest and your great work. What I am saying is that I think the Department needs to look again at the division of funds in meeting the problem, and I would hope you would do that and let the committee know, because we will want to go into this further in future discussions.

Dr. MIDDLETON. I appreciate your interest.

Mr. ROGERS. Are there any further questions?

Yes, Mr. Skubitz.

Mr. SKUBITZ. Doctor, I believe you said there were standards established for automobiles?

Dr. MIDDLETON. Yes.

Mr. SKUBITZ. Does it apply to old cars?

Dr. MIDDLETON. It does not. One has to understand that the emission regulations are for new motor vehicles only, and the ordinary motor vehicle lasts 10 years and goes 100,000 miles.

Mr. SKUBITZ. What percentage of the automobiles on the road today are new model cars as compared with old cars?

Dr. MIDDLETON. We have one-fifth of the population under control today, and that is the tragedy of the situation.

Mr. ROGERS. Have you asked Congress for authority to set standards for used cars?

Dr. MIDDLETON. We have not asked for authority on used cars. The information available at the present time suggests it is much better

to see that there are really strong standards on new cars because of the apparent difficulties in retrofitting the great variety of makes and models presently on the road.

Mr. ROGERS. We only have four major manufacturers. I wouldn't think it would be too difficult, and I would think that some of this budget would be devoted to that problem, because I would agree with the gentleman that that is a problem.

Dr. MIDDLETON. We will be devoting a portion of our funds to the cleanup of the buses and diesels.

Mr. SKUBITZ. I was also interested in what you had to say about removing sulfur from coal. I think you said you had developed several methods. Would you mind restating the methods that are used?

Dr. MIDDLETON. The deep cleaning of coal—may I ask Mr. Smith to respond to that?

Mr. SMITH. Crushing, grinding, and getting it to fine particle size. If you can recall gold panning, where one washed particles—

Mr. SKUBITZ. It is the flotation system.

Mr. SMITH. Yes.

Mr. SKUBITZ. Do you carry on the actual experimentation?

Mr. SMITH. Most of this is not work that we carry on in our own shops at all, but efforts we hope to fund jointly with the Bureau of Mines, by way of example, and the private sector.

Mr. SKUBITZ. You say you are working with the Bureau of Mines. How much money have you turned over to the Bureau of Mines to carry on this sort of work?

Dr. MIDDLETON. Most of the coal cleaning Mr. Smith mentioned is being done by the bituminous coal research group, as well as McNally-Pittsburgh Manufacturing Co., and Roberts & Schaefer Co.

The Bureau of Mines in the Department of Interior, in 1969, we had a transfer of funds of \$1,780,000.

Mr. SKUBITZ. For what?

Dr. MIDDLETON. Those that dealt specifically for sulfur oxides were about \$1.2 million. That would be the evaluation of metal oxides as a flue stack cleaning system, an evaluation of where coal resources are, the removal of pyrites from coal, and particularly the cost of the cleaning systems.

Essentially, it is looking at the availability of low sulphur coals, where are they, are they mineable, can they be used. It is helping the Department of Interior and Bureau of Mines to use the expertise they have on fuel resources as well as information they have on the use of metal oxides and flue stack cleaning.

Mr. SKUBITZ. What I am getting at, Doctor, is this: The Bureau of Mines will come to the Committee on Interior and Insular Affairs and ask for funds to carry on research. Then you come in and ask for money to do the same thing. It is transferred back to the Bureau of Mines. We don't know whether they are doing the research on the money we gave them for their own use, or whether they are carrying on research that you have directed.

Dr. MIDDLETON. The Clean Air Act, as amended, clearly states that the Secretary of Health, Education, and Welfare has the responsibility of carrying out the intent of the act.

Through our liaison with them, and the development of the comprehensive planning report, we have involved the Department of the

Interior, the Bureau of Mines, the Tennessee Valley Authority, the Department of Commerce, the Federal Power Commission, all of those entities that have something to do with air pollution.

We have had a meeting with them on what their program should be, what their requirements are, and the budget we are presenting reflects that integrated approach.

When it comes to fuel conversion, the Office of Coal Research has a view on the utilization of fuels.

Where those projects relate to air quality, we will participate with them.

So there is not a conflict in the sense of funding for these projects. There is a clear understanding where the responsibility lies, and we certainly do not expect to develop an expertise in knowing where the fuel beds are located, but we expect to use their expertise.

Mr. SKUBITZ. You are interested in the removal of sulfur from coal from the standpoint of air pollution, and they are interested in the same thing from the standpoint of industrial use.

So both of you are working on the same problem, and you are both looking for the same thing.

Dr. MIDDLETON. But we are doing it as one program, and it is for that reason that the moneys that are allocated under our authorization are transferred to the Bureau of Mines to see that the air pollution work is conducted in an organized way under the authority given by Congress to the Department of Health, Education, and Welfare.

Perhaps there should be improvement in our liaison, and I will be pleased to look into it.

Mr. CARTER. Mr. Chairman, I think we should think about the location of coals with certain percentages of sulfur dioxide. I was under the impression a few years ago that we knew the locations of coals of high sulfur content. In fact, we have had tables here in this committee with the percentages of sulfur dioxide and where they came from, what sections of the country.

Why are we going further with this when we already know about it?

Mr. SMITH. Sir, we have surveys made by the Bureau of Mines and by others on the location of low sulfur coals. These are generally viewed as pessimistic estimates of the location; that is, this is not a criticism. It is just a question of to what degree have we positively identified the underground extent of the field, and therefore can classify it as a reserve with reference to its sulfur.

Obviously, the more low sulfur coal can be found, the lower the cost of the coal. If one could find quantities of such coal in the vicinity of Chicago, the transportation cost would be less, and supposedly this would make it cheaper for use in the Chicago metropolitan area.

In the same fashion, low sulfur coal has a metallurgical use, and one important use is captive coal for the metallurgical industry.

We are looking in another frame of reference in conjunction with the Bureau where development of further knowledge as to the resources that might be tapped for utilities, by way of example, and cheaply tapped.

Mr. CARTER. Thank you.

I believe these fields have been well explored.

If you would yield a little further, sir, I am afraid that we are not going to find any coal low in sulfur dioxide close to Chicago. We know

the location of most of this, and also you are speaking of captive industries. Some of the fields which probably you refer to are still owned by private operators, or small operators, and it is true that coal in this area, just a small percentage of it, is used in metallurgical areas, in the field of metallurgy. They mix it, as I recall, using only 40 percent of coals from the area which I have the honor to represent, in manufacturing, coal, and steel.

They mix it with the high-sulfur-content coals.

Mr. SKUBITZ. Doctor, I think you said you allocated \$1,870,000 to the Bureau of Mines to carry on this experimental program to resolve sulfur from coal.

You are also working with the McNally Co. How much money did you turn over to the McNally Co.?

Dr. MIDDLETON. That company would be on the contract list the chairman has asked for, the contract arrangements in the sense that we ask for prospective bidders to go through the bid procedures.

Mr. SKUBITZ. How about Gulf Oil?

Dr. MIDDLETON. I will have to make a determination of that from our contract list. I am sorry. I do not recall.

Mr. ROGERS. Let me ask you this.

What about mass transit? On these buses and so forth, are you setting the standards, or is the Department of HUD?

Dr. MIDDLETON. The emission regulations are the responsibility of the Secretary of Health, Education, and Welfare.

Mr. ROGERS. And research?

Dr. MIDDLETON. There is a concern on our part that we have an integrated motor vehicle research and development plan. We are now at the present time working out with the Department of Transportation what their research interests are so that we can have a total effort in this area.

I cannot now describe this to you because the plan is now in preparation, Mr. Rogers.

Mr. ROGERS. In other words, so far as we know, HUD may also be doing research in the mass transit area for pollution?

Dr. MIDDLETON. I believe all the transportation aspects that were formerly in Housing and Urban Development have been transferred to the Department of Transportation, and DOT now has that responsibility.

We do have a liaison relationship with them. In fact, there is one person assigned that is liaison to the Department of Transportation.

Mr. ROGERS. Do we know what they are doing in this area?

Dr. MIDDLETON. We are now in the process of finding out what they wish to do. We know what they are doing. This is primarily demonstration.

Mr. ROGERS. On pollution?

Dr. MIDDLETON. On pollution control that relates to buses. Steam, freon, and a Rankine cycle.

Mr. ROGERS. Could you give us a rundown on that?

Dr. MIDDLETON. I will be pleased to give you what is available.

(The following information was received for the record:)

CURRENT AND PROJECTED FUTURE RESEARCH AND DEVELOPMENT ACTIVITIES PERTAINING TO MOTOR VEHICLE POLLUTION CONTROL—INFORMATION SUPPLIED BY DEPARTMENT OF TRANSPORTATION TO NATIONAL AIR POLLUTION CONTROL ADMINISTRATION

The National Air Pollution Control Administration currently is developing a long-range plan for research and development on motor vehicle pollution control. The plan will encompass the relevant activities of all Federal departments and agencies, and will include research and development relating not only to the internal combustion engine but also to alternative, low-pollution propulsion systems for motor vehicles. In the course of developing this plan, the National Air Pollution Control Administration has contacted other Federal agencies for information on their current and projected future research and development activities pertaining to motor vehicle pollution control. The following is a summary of information furnished by the Department of Transportation:

1. The Urban Mass Transit Authority is supporting two projects to demonstrate the use of Rankine-cycle engines in buses. A grant has been made to the City of Dallas for testing of engines using freon as the working fluid and propane as the energy source. A grant has been made to the State of California for testing of steam engines.

2. In Fiscal 1970, the Urban Mass Transit Authority plans to initiate two additional demonstration projects, both of which will involve the use of unconventional engines in buses. One of these projects will be a demonstration of the Stirling-cycle engine. The other involves hybrid-electric propulsion systems, including combinations of flywheels, heat engines, and electrical battery systems. The National Air Pollution Control Administration plans to join the Urban Mass Transit Authority in supporting the study of flywheel systems.

3. The Bureau of Public Roads is cooperating with the National Air Pollution Control Administration and the City of New York in a study of the air pollution implications of the proposed Lower Manhattan Expressway. The National Air Pollution Control Administration has awarded a grant of \$190,000 to the City of New York to support the study.

Mr. ROGERS. If there is other information available, let us know, and the committee will make inquiry to DOT.

Let me ask you this.

What input in environmental health concerns is going into the comprehensive State health planning and the expenditure of funds, partnership funds, and so forth?

Dr. MIDDLETON. I do not have any budget figures on what is being spent through that money for air pollution control. I would speculate that it is minimal, since the funds for air pollution control are within the appropriations in the Clean Air Act, and we give those to eligible agencies through our control program grant activity.

Mr. ROGERS. Are you encouraging the State people at all to get into comprehensive health planning in an environmental way?

Dr. MIDDLETON. We are a party to that development. We offer technical assistance so far as we can to be sure that a comprehensive health plan does recognize that air quality be a part of the State plan.

Mr. ROGERS. Is this being done everywhere?

Dr. MIDDLETON. It is not being done everywhere, or not being done uniformly everywhere.

Mr. ROGERS. Would you give us the specifics on that?

Dr. MIDDLETON. I will attempt to get whatever information is available. At the present time we may not be able to supply that quickly, because some of these plans are in evolution, and we can give it to you at the current date, but it may be rather incomplete.

Mr. ROGERS. Give us what you can on that.

(The following information was received for the record:)

THE EXTENT TO WHICH ENVIRONMENTAL PROBLEMS ARE DEALT WITH THROUGH
THE COMPREHENSIVE HEALTH PLANNING (PARTNERSHIP-FOR-HEALTH) PROGRAM

Available indices for measuring the degree of environmental health involvement under the Comprehensive Health Planning (Partnership-for-Health) Program are few and relatively imprecise.

An analysis of the "plans for planning" submitted by the state comprehensive health planning agencies, supported under subsection 314 (a) of the Public Health Service Act for F.Y. 1968 indicated (1) that the advisory councils of about half these agencies include one or more persons with environmentally-related backgrounds, (2) that most such agencies had formed environmental health subcommittees and (3) that most were planning to perform some kind of study of environmental health problems (including air pollution).

Data submitted by the area-wide comprehensive health planning agencies, supported under subsection 314 (b), PHS Act, are not very conclusive since most of those agencies are still in the early stages of organization.

Most projects approved for conducting training in comprehensive health planning under 314 (c), PHS Act, have demonstrated an intention to include the environmental health aspects of planning.

An analysis of data included in the state plans for public health services, submitted under 314 (d), PHS Act, indicates that about 8½% of the 314 (d) grants will go for environmental health purposes in F.Y. 1969.

Under 314 (e), PHS Act, about 20% of total funds allotted for F.Y. 1969 will be directed to predominantly environmental health projects—chiefly due to the earmarkings of \$15.0 million for rat control projects.

That so relatively little of the funds available under 314 (d) and (e) go to environmental purposes can be attributed to several causes, including: (1) the categorical programs whose funds were originally transferred to the Partnership-for-Health program to get it started have been more or less continued by the states, under 314 (d), and have been continued by earmarking under 314 (e), and those original programs were predominantly non-environmental; (2) substantial additional funds have not been made available under these subsections in subsequent years, thus not encouraging new undertakings in the environmental or other new fields; and (3) the comprehensive health planning activities to be performed by the 314 (a) and (b) agencies are just getting under way, or have not yet started, and consequently the expected impact of this planning on the utilization of the 314 (d) money has not yet been felt.

Mr. ROGERS. We are concerned that they consider environmental health in a comprehensive plan.

It is most important, and I would hope they would begin to do that.

Dr. MIDDLETON. We would like to be certain that they have air up in front of them when they consider this, but it is not a part of our direct funding responsibility.

Mr. ROGERS. Are there any other questions?

If not, thank you very much. We appreciate your presentation.

The committee will stand adjourned.

(The following letters were received for the record:)

IONICS, INC.,

Watertown, Mass., June 20, 1969.

Representative HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
Washington, D.C.

MY DEAR REPRESENTATIVE STAGGERS: Your Committee is reporting out a bill in the next few days either to extend Section 104 of the Air Quality Act of 1967 or to make some other similar provisions to make available extra funds for the Federal technical effort against air pollution. I wish to record the endorsement of Ionics on this action, and enclose an article describing our process for the removal of SO₂ from stack gases.

The Federal air pollution program is at a phase now when it is critical to convince potential users (such as utilities) of air pollution control processes of their practicality. They are waiting either for the "stick" of regulations to force them or the "carrot" of practicality and profit to induce them. The leadership of

the Federal program has been focused more on regulations to date. Under the time tables called for by the Air Quality Act of 1967, regulations should begin to be promulgated one year from now, and enforced "within a reasonable time" thereafter. Certainly in 3 years from now regulations will begin to significantly affect utilities. We must move *now* to support demonstration plants (also taking 3 years, as I pointed out above) to avoid the situation then of the utilities claiming control is impossible for lack of a practical process, and thus frustrating the intent of the Act, or grossly expensive by using scarce low-sulfur fuel and hitting the taxpayers so hard in his pocketbook that he rebels, also frustrating the intent of the Act.

Sincerely yours,

RUSSELL L. HADEN, Jr.,
President.

[From Chemical Week, Aug. 10, 1968]

SULFURIC ACID FROM POWERPLANTS THROUGH ELECTROLYSIS

SULFURIC AS A UTILITY'S PROFITABLE BY-PRODUCT

One strong selling point for the new electrolytic process to recover sulfur dioxide from power-plant stack gases: it makes the electric company one of its own best customers for electricity. The process was developed by Stone & Webster Engineering Corp. and Ionics, Inc.; the two firms now plan to build a demonstration unit (*CW Technology Newsletter*, July 20).

Heart of the SO₂ removal and recovery operation (*flowsheet, above*) is a membrane-type electrochemical cell (*photo, above*) that generates caustic soda, sodium acid sulfate (NaHSO₄), dilute sulfuric acid, oxygen and hydrogen from a solution of sodium sulfate. The dilute sulfuric and oxygen become supplemental feed streams for a nearby sulfuric acid plant; the hydrogen can be bottled in cylinders for local markets.

Electric power requirements of the electrolytic cells are considerable—about the same as a good-size chlorine-caustic cell room's—and the utility would install "spinning reserve" to handle it. Example: a 1,200-megawatt station would need 80–83 mw. for cell power. But, at the first sign of power brownout, the system operator has instant interruptibility at his fingertips. He can start shedding the load by cutting off the current flow to the electrolytic cells, one line at a time.

In most cases, this should be enough to tide the system over in peak-load periods such as hot, midweek afternoons, and thus prevent service interruptions to paying customers. Only the power-plant station service account shows an interruption. Also, standby gas turbines (which have relatively high operating costs) can remain on standby.

Built-in Catch-up: J. J. Humphries, Jr., of Stone & Webster's corporate planning and development department, tells *CW* the SO₂ recovery system has built-in tankage on either side of the cell room that permits about 760 hours/year of absorption without cellroom power. Assume that the peak load occurred late in the day on a Wednesday or Thursday. Absorption of SO₂ could continue uninterrupted with the cells shut down. Then over the light-load weekend, the cells would come on again and catch up, ready for normal operation on Monday morning.

Apparently, Ionics, Inc., has developed a membrane for the patented process (U.S. 3,135,673 and 3,222,267) that is unaffected by interruption. Also, it reportedly succeeds in isolating the caustic soda and sodium acid sulfate formed in the electrolysis of sodium sulfate—a separation that has never before carried out commercially. According to handbook descriptions of the chemistry involved in this process: "Difficulty in separating the anolyte and catholyte from each other, lack of good materials for anodes and diaphragms, high energy consumption and other unsolved problems have retarded the development of the electrolysis of sodium sulfate solution."

Russell Haden, president of the Ionics General Division, attributes the success of the new approach to his company's extensive experience in electrochemical processes, including the Monsanto method for dimerization of acrylonitrile. Ionics and S&W say the new process—in which the first step is use of caustic soda solution to scrub SO₂ out of the stack gas—had a successful pilot-plant tryout during last-half '67 on the flue gas from commercial boilers at the Gannon Station of Tampa Electric Co. (Tampa, Fla.).

What's the Cost? S&W has prepared detailed capital and operating cost estimates indicating that sales of recovered SO_2 not only would cover operating expenses but also would actually give the utility an acceptable rate of return on the invested capital.

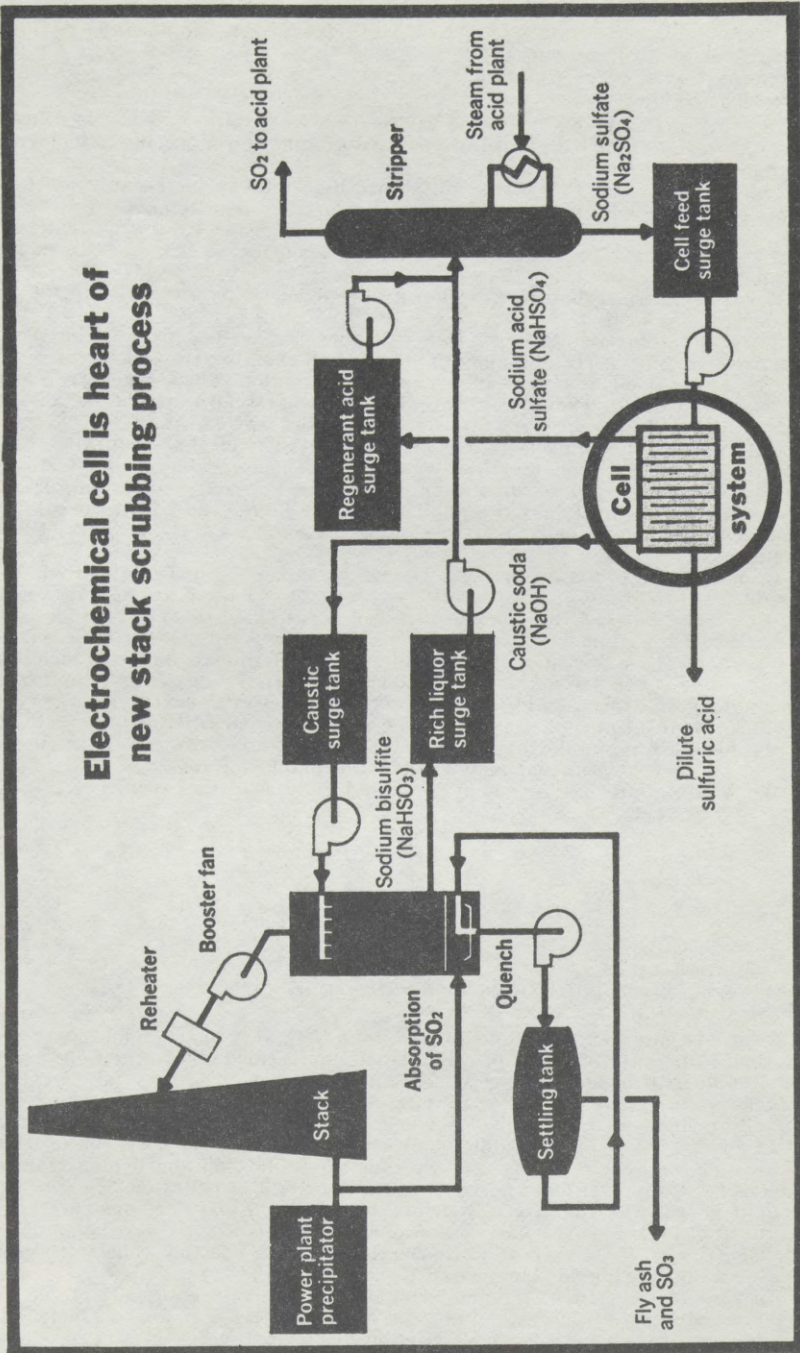
Basic assumption: the process can reduce the sulfur dioxide content of the stack gas to 50–150 ppm. Capital cost varies with five conditions: power-plant size, number of boilers, position of existing ductwork, sulfur content of the fuel, and power-plant load factor. Operating cost is a function of energy cost, sulfur content of the fuel and SO_2 content of the effluent gas. End-products: 99% sulfuric acid, hydrogen and oxygen.

At June '68 prices, S&W estimates, a 1,200-mw. electric station burning 3.5%-sulfur coal in four boilers would require an investment of \$18.5 million. Ductwork, dampers, reheaters, distribution substation, sulfuric acid plant, interest during construction, initial chemical charge and initial supply of membranes, electrodes and spare parts are included.

To remove 90% of the SO_2 from the stacks, operating costs at a Midwest location are set at \$2,972,000. Income of \$5,810,000 during the first year of operation would come from the sale of 340,000 tons of 99% sulfuric acid at \$17/ton. No credit is taken for merchant sales of oxygen and hydrogen.

Thus, S&W predicts a 5.24% return after federal income taxes (52.8%) during the first year. Average return over the 20-year depreciation life of the plant: 9.6%.

Electrochemical cell is heart of new stack scrubbing process



FIRE ENGINEERS INC.,
Minneapolis, Minn., June 20, 1969.

Congressman ANCHER NELSEN,
Rayburn House Office Building,
Washington, D.C.

DEAR ANCHER: As we discussed earlier this week, our company is concerned about certain local and state pollution control regulations applying to incinerators which we manufacture.

I should say, first that we manufacture high quality incinerators with very low emission levels, which will meet all emission requirements of which we are aware. Consequently, we do not object to emission level requirements. In fact, we regularly encourage governmental agencies to enact strict emission regulations.

We are concerned, however, with a proliferation of requirements in the areas of design and testing.

State and local regulations often call for specific designs, ranging from a requirement for a certain number of combustion chambers to another one calling for 11 gauge steel to be used in the wall construction. These rules are not consistent from one jurisdiction to another, making it necessary for incinerator companies to design special units for many cities and states.

Our company's feeling is that control of emission levels is sufficient for the control of air pollution and that we would be better able to serve our customers, at lower prices, if design requirements were eliminated or made optional. We also feel that the public would be better served by this approach since efficient, inexpensive incineration is needed to solve our waste disposal problems.

In addition, there is an increasingly large number of jurisdictions which are establishing their own test methods. Each of these methods represents a sincere effort on the part of the officials involved to establish a good test procedure. However, it is extremely expensive for us to have separate tests run on our units for each of these jurisdictions. In addition, even though many agencies have adopted one of the five major test methods, they often require that the test must be run on a unit installed in their state or county, even though the test may have been run many times on the same model in other jurisdictions.

We feel that a standardized test method, acceptable throughout the country, would be very helpful and would be in the public interest.

We would appreciate any help you could give us in this regard.

Yours very sincerely,

BONN H. CLAYTON,
Director of Environmental Control.

NATIONAL COAL POLICY CONFERENCE, INC.,
Washington, D.C., June 25, 1969.

Hon. JOHN JARMAN,
Chairman, Subcommittee on Public Health and Welfare,
Washington, D.C.

DEAR MR. JARMAN: On June 19, Dr. John T. Middleton, Commissioner of the National Air Pollution Control Administration, testified before the Subcommittee on Public Health and Welfare on H.R. 12085 (introduced by Chairman Harley Staggers) to extend for one year the authorization for Congress to appropriate funds to carry out the provision of Section 104 of the Air Quality Act of 1967.

In his testimony, Dr. Middleton described how the Department of Health, Education, and Welfare has used Section 104 to develop and demonstrate techniques for the prevention and control of sulfur oxides pollution. He pointed out that it is essential that HEW continue the research and development activities authorized by this particular section of the Air Quality Act and he emphasized that Section 309—the general authorization section—does not contain the special features that are included in Section 104.

In view of the strong statement Dr. Middleton made in support of the extension of Section 104(c) for another year, I was surprised at his conclusion stated as follows: "While extension of Section 104 is not necessary, if the Congress determines that the proposed one-year extension is desirable, we would not object to its enactment."

The National Coal Policy Conference, Inc., believes that it is important that Section 104(c) be extended, as provided in H.R. 12085, because this particular section of the Air Quality Act focuses on the most critical area of air pollution control—the accomplishment of the research and development necessary to eliminate or reduce air pollution resulting from the combustion of fuels from both stationary and motor vehicle sources. That section of the Air Quality Act was designed to assure that research and development in this vital area was given top priority and to provide the broad authority and funding authorizations necessary to accomplish the difficult tasks involved.

There are a number of legal and policy reasons for extending the authorization under Section 104. From a policy point of view, in the very calendar year when the Department of Health, Education, and Welfare has issued its Air Quality Criteria and Control Data pertaining to sulfur oxides and particulate matter, it would be most unfortunate to in any way give the impression that the achievement of the air quality which those documents describe could be accomplished without a major research and development effort. Certainly the implication of the expiration of the funding authorization would be either that the job has been accomplished or that the Congress no longer considers it of top priority.

But the facts are just the opposite. In view of the delays which have been encountered in nuclear power plants going on line, and in view of our rapidly growing power demands, it is clear that the use of fossil fuels as the prime source of electric power will greatly increase in the next decade. At the same time, we are still a long way from satisfactory solutions to the related air pollution control problems and only a small part of the funds authorized under Section 104 were ever appropriated. Thus the need for Section 104 is greater today than it was in 1967.

In addition to the policy considerations, from a legal point of view there are a number of important specific provisions in Section 104 which are not explicitly covered elsewhere in the Air Quality Act. This includes:

1. Authority for the construction, operation, and maintenance of demonstration plants or processes.
2. Authority for studies leading to new or improved methods for the recovery and marketing of commercial valuable by-products resulting from the removal of pollutants.
3. Authority for the support of projects involving construction and installation of pollution control equipment on private property for the purpose of testing.
4. Authority for funds to remain available until expended.

At best these authorizations can be read into other provisions of the Act, but they may be subject to considerable uncertainty and debate. Also, it should be noted that section 309 specifically excludes Section 103(d) and Section 104 with respect to the use of funds there authorized to be appropriated. Therefore, if the authorization under Section 104 expired, it certainly would leave in doubt whether any program that fell within the specific provisions of Section 104 could also be held to fall within the scope of the general research provisions of Section 103, there is no reason for leaving this matter in such an uncertain status.

We believe that it is important, if we are to achieve the objective of cleaner air, and do so in an orderly and economically feasible manner, that the Secretary of Health Education, and Welfare be directed, as set forth in Section 104(a), to
 “. . . give special emphasis to research and development into new and improved methods, having industry-wide application, for the prevention and control of air pollution resulting from the combustion of fuels . . .”

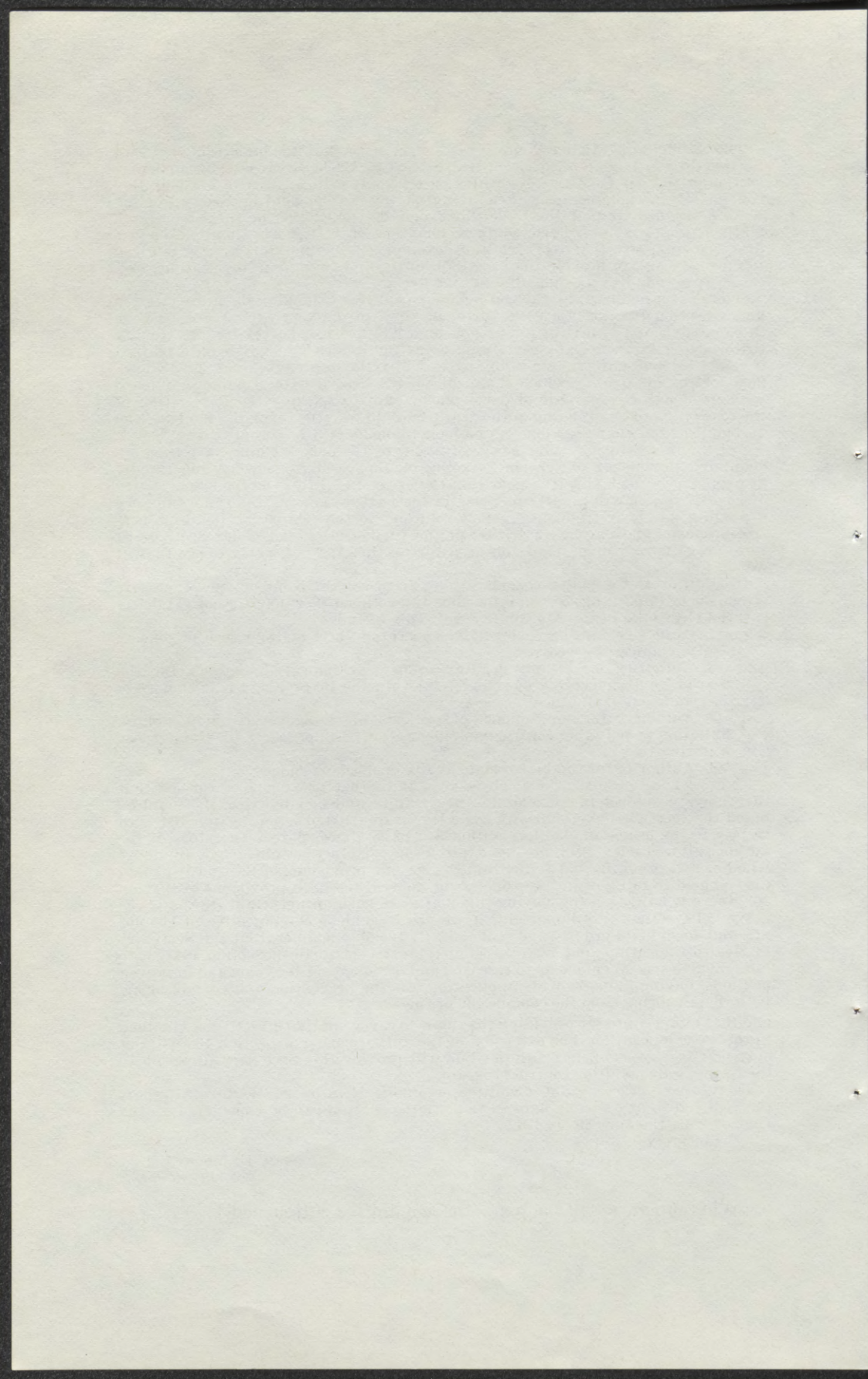
and that a procedure for providing the funds to carry out this directive be retained in the basic legislation. The extension of the authorization of Section 104 will not only clarify any legal uncertainties but will provide this necessary direction to the Nation's air pollution control program.

Therefore, I urge the Subcommittee on Public Health and Welfare to report the H.R. 12085 at an early date so that the legislation can be considered by the House before the June 30 deadline.

Sincerely,

JOSEPH E. MOODY,
President.

(Whereupon, at 12:05 p.m., the committee adjourned.)



APPENDIX A

91ST CONGRESS }
1st Session }

SENATE

{ DOCUMENT
No. 91-9

NATURE AND CONTROL OF AIRCRAFT
ENGINE EXHAUST EMISSIONS

REPORT
OF THE
SECRETARY OF HEALTH, EDUCATION,
AND WELFARE
TO THE
UNITED STATES CONGRESS
PURSUANT TO
Public Law 90-148
THE AIR QUALITY ACT OF 1967

DECEMBER 1968



MARCH 4, 1969.—Ordered to be printed with illustrations

U.S. GOVERNMENT PRINTING OFFICE

WASHINGTON : 1969

25-138

SENATE RESOLUTION 86**Submitted by Mr. Randolph of West Virginia**

IN THE SENATE OF THE UNITED STATES,
Agreed to March 4, 1969.

Resolved, That there be printed with illustrations as a Senate document the report of the Secretary of Health, Education, and Welfare, entitled "Nature and Control of Aircraft Engine Exhaust Emissions", submitted to the Congress in accordance with section 211(b), Public Law 90-148, the Air Quality Act of 1967, and that there be printed two thousand five hundred additional copies of such document for the use of the Committee on Public Works.

Attest:

FRANCIS R. VALEO,
Secretary.

(II)

LETTER OF TRANSMITTAL

THE SECRETARY OF HEALTH, EDUCATION, AND WELFARE,
Washington, D.C., January 17, 1969.

HON. HUBERT H. HUMPHREY,
President of the Senate,
Washington, D.C.

DEAR MR. PRESIDENT: In accordance with the provisions of title II, section 211(b) of Public Law 90-148 (the Air Quality Act of 1967), I am pleased to transmit the report on the control of aircraft engine emissions.

The intent of this report is to summarize available information on the nature and extent of air pollutant emissions by jet and piston aircraft engines in the United States and to discuss the feasibility and practicality of controlling these emissions.

Sincerely,

WILBER J. COHEN,
Secretary.

(III)

PREFACE

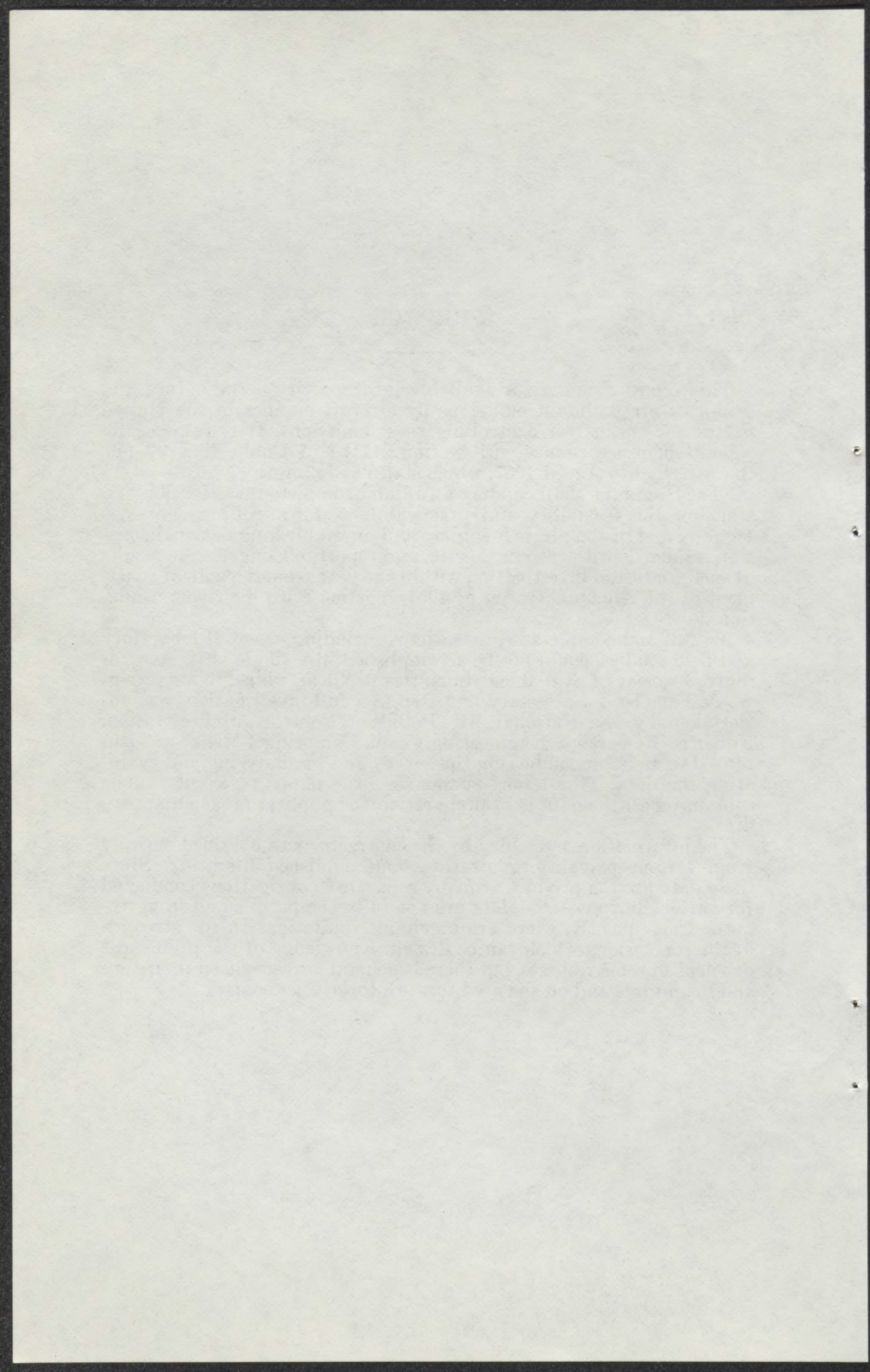
This report summarizes available information on the nature and extent of air pollutant emissions by aircraft engines in the United States and means for controlling these emissions. It is respectfully submitted in accordance with section 211(b) of Public Law 90-148, the Air Quality Act of 1967, which states as follows:

"The Secretary shall conduct a full and complete investigation and study of the feasibility and practicability of controlling emissions from jet and piston aircraft engines and of establishing national emission standards with respect thereto, and report to Congress the results of such study and investigation within one year from the date of enactment of the Air Quality Act of 1967, together with his recommendations."

A "full and complete investigation," including essential laboratory and field studies, could not be accomplished in a single year. Accordingly, a survey of available data on this problem, which, in any event, would have been a necessary first step in a full investigation, was undertaken by the National Air Pollution Control Administration. Northern Research & Engineering Corp., Cambridge, Mass., was employed to assist in conducting the survey and in analyzing and evaluating the data. This report summarizes the data. A second volume containing all the data is in preparation for publication as an appendix.

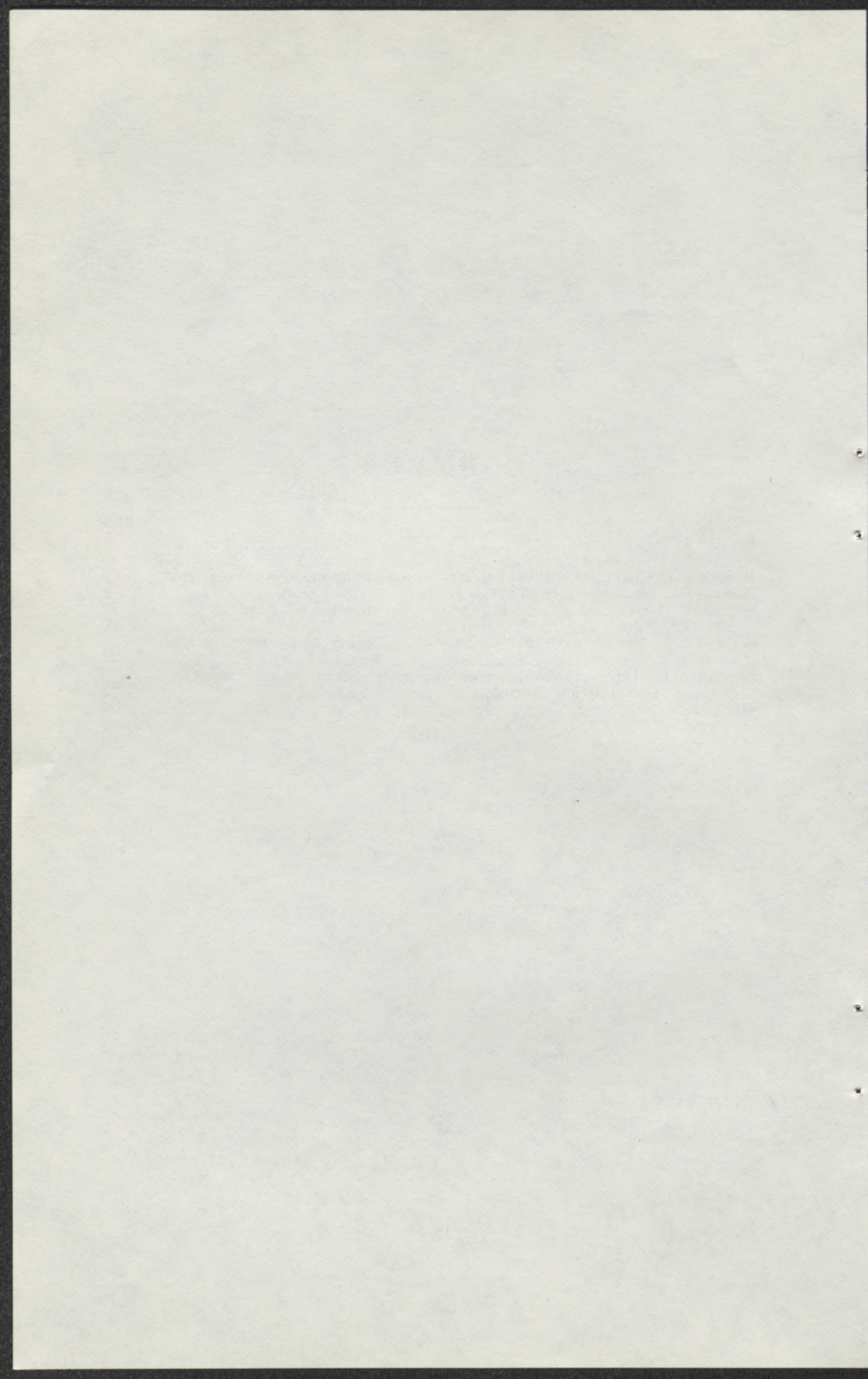
The information assembled by the contractor was obtained entirely from various private organizations and published literature. Since these data are the product of many separate investigations conducted for various purposes, the data are not fully compatible and in agreement. Consequently, there are inevitable limitations in the strength of the conclusions which can be drawn. Knowledge of the problem is deficient in some respects, but there is general agreement on its nature and magnitude and on the need to work toward its control.

(V)



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NATURE AND CONTROL OF AIRCRAFT ENGINE EXHAUST EMISSIONS

I. INTRODUCTION

Relatively little attention was given to aircraft as a source of air pollution until the later 1950's, when turbojet aircraft were introduced into the Nation's commercial air carrier fleets. The turbojets emitted highly visible exhaust plumes during takeoff and landing operations. Use of water injection for increased power during takeoff was often said to be responsible for the exhaust plume density but the discontinuation of this technique has not eliminated smoke from jet aircraft. The density of the exhaust smoke from jet engines and the odor characteristic of the fuel have prompted demands for reduction of jet aircraft emissions.

Early studies of the problem were undertaken by the Los Angeles County Air Pollution Control District (1) and by the Coordinating Research Council (2). The report on the Los Angeles study, issued in April 1960, concluded that "total contaminant emissions from jet aircraft operations are at this time insufficient to produce any generalized deterioration of air quality," and that "visible smoke emissions from commercial jet aircraft * * * do not constitute violations of opacity standards." No evidence of property damage was found. The report by the Coordinating Research Council, also issued in 1960, concurred generally with the Los Angeles report, concluding that "the relative magnitudes of the emissions from aircraft and from ground vehicles are such that we do not feel further study is warranted by (this) group."

By mid 1964, however, there was sufficient concern about aircraft emissions to prompt the inclusion of this subject in hearings held by the Subcommittee on Air and Water Pollution of the U.S. Senate Committee on Public Works. The record of these hearings has been published (3).

In 1965 the Los Angeles County Air Pollution Control District undertook a second study of aircraft emissions which resulted in a more comprehensive report on the pollutant emissions from all types of civil aircraft in the district (4). As a result of the inclusion of piston-engine aircraft in this study, total emissions attributable to aircraft were found to be substantially higher than the estimates made previously. This study found that aircraft were responsible for between 1 and 2 percent of all organic gases, carbon monoxide, and oxides of nitrogen emitted in Los Angeles County and approximately 10 per-

NOTE.—Number in parentheses refer to references cited on p. 31.

cent of all aerosols (particulates). These findings were brought to the attention of the U.S. Congress during hearings held in February 1967 by the Senate Subcommittee on Air and Water Pollution (5). The complete 1965 Los Angeles study report is included in the published record of the subcommittee hearings. Subsequently, the Air Quality Act of 1967 specifically identified aircraft emissions as a subject of concern and required an investigation by the Department of Health, Education, and Welfare.

II. SUMMARY

A. IMPACT OF AIRCRAFT EMISSIONS

1. Exhaust emissions from piston and jet aircraft include the same pollutants emitted by highway vehicles, as well as certain other pollution sources, and, consequently, participate in the same air pollution problems.

2. The present contribution of aircraft emissions to the total atmospheric pollution burden of the community is considered small. The magnitude of this relative contribution is expected to grow, largely as a result of effective emission control legislation applicable to highway vehicles. By 1980, for example, carbon monoxide from aircraft is expected to account for 3 to 5 percent of the carbon monoxide emissions in Los Angeles County versus a present contribution of less than 1 percent.

3. Based on emission densities, the average level of atmospheric pollution at selected air terminals and their immediate vicinity is calculated to be of comparable magnitude to that in the communities in which the terminals are located.

4. Under conditions of heavy airport traffic, exposures to high concentrations of exhaust contaminants are likely to occur in aircraft loading areas and in the cabins of aircraft lined up awaiting takeoff.

5. The public's reaction to air pollution in the form of smoke and odor from jet aircraft is evident from complaints and newspaper accounts. Response, both in the form of legislative action and attempts by industry to find a solution to the visible emissions problem, has been notable.

B. CONTROL OF AIRCRAFT EMISSIONS

1. Principles of combustion and engine operating conditions similar to those which account for emissions from highway vehicles are responsible for emissions from aircraft engines. Subject to special safety considerations, aircraft engine emissions are generally amenable to the same principles as applied to motor vehicle emission control technology.

2. Turbine-engine combustor technology for effectively eliminating the visible plume seems assured for application in the very near future, both to new engines and to replacement combustor components for existing engines. When applied to existing aircraft, according to regular replacement schedules of such engines and combustor units, the cost is not expected to be a significant factor. Safety, in terms of engine relight characteristics, is not expected to be degraded thereby.

3. Total particulates, hydrocarbons and carbon monoxide emissions reduction from turbine engines may be realized as a consequence of improved combustion design for improved performance and for the control of visible emissions.

4. Aircraft engine emissions in the lower atmosphere are primarily the result of ground operations, and the approach and takeoff segments of an aircraft's flight pattern. Airport designs which minimize aircraft ground operations, plus the use of low-pollution aircraft-to-terminal transportation can produce meaningful results in all receptor areas.

5. Control measures applicable to aircraft piston engine emissions are dependent on developing definitive data on emission impact and the development of control technology.

6. The control of oxides of nitrogen from aircraft is not deemed to be feasible on the basis of current information.

7. Control of aircraft emissions by altering fuel composition is not indicated in the light of the control potential of other approaches considered.

C. CONCLUSIONS AND RECOMMENDATION

1. Reduction of particulate emissions from jet aircraft is both desirable and feasible. Engine manufacturers and airlines have indicated that improvements in turbine engine combustor design can be built into new engines and retrofitted on engines already in use. Testing programs are already underway. Furthermore, they have indicated that application of this technology will be underway by the early 1970's. While there are no laws or regulations to compel the industry to follow through on this work, it appears that public pressures resulting primarily from the adverse effects of odors and visibility obscuration will lead industry to initiate the application of this technology as soon as possible and to complete it within the shortest possible time. Accordingly, it is the intention of this Department to encourage such action by engine manufacturers and airline operators and to keep close watch on their progress. If, at any time, it appears that progress is inadequate or that completion of the work will be unduly prolonged, or that the concern of the industry lags, the Department will recommend regulatory action to the Congress that statutory authority for such action be provided.

2. Further research is needed to define more precisely the present and probable future nature and magnitude of all other air pollution problems associated with aircraft activity in the United States and to identify needs for control measures. Emphasis must be placed particularly on assessment of air pollutant levels in the air terminal environment and their effects on health and safety and on evaluation of possible long-term effects of upper atmospheric pollution resulting from aircraft flight activity. The Department will undertake research appropriate to the solution of this problem.

3. As further research results in identification of needs for additional measures to control air pollution from any type of aircraft, and as measures to achieve such control become available through research and development, it is the Department's expectation that engine manufacturers, airline operators, and other segments of the aviation community will take the initiative in the development and application of such control measures. If the private sector fails to provide adequate controls, the Department will not hesitate to recommend to the Congress that Federal regulatory action be authorized.

4. In light of the relatively small contribution of aircraft to community air pollution in all places for which adequate data are available, and in view of the practical problems that would result from State and local regulatory action in this field, it is the Department's conclusion that adoption and enforcement of State or local emission control regulations pertaining to aircraft cannot be adequately justified at this time. The Department recommends that, if and when regulations become necessary, the rationale used to develop Federal rather than local emission standards for motor vehicles be applied to aircraft.

5. The Department recognizes that State and local agencies, in cooperation with the Federal Aviation Administration and other cognizant agencies, are the most appropriate groups to insure that control of airport pollution hazards will be given adequate consideration in the selection of airport sites, planning for expansion and reconstruction of airports, design of airports, and planning and conduct of ground operations.

6. The Department will include information on progress in the control of air pollution from aircraft in the annual report which must be submitted under section 306 of the Air Quality Act.

III. CHARACTERIZATION OF AIRCRAFT EMISSIONS AND ANALYTICAL METHODS

A. EMISSION CHARACTERISTICS

Atmospheric contaminants emitted by aircraft include the same types emitted by cars, trucks, and buses. The major gaseous pollutants are carbon monoxide, hydrocarbons, oxides of nitrogen, and oxygenated organic compounds. The important particulate emissions include carbon in the form of smoke from jet aircraft and carbon as well as lead compounds from the exhaust of piston aircraft.

Table 1 compares the emission indices for two basic types of aircraft engines with automobiles. Data for automobiles are for passenger cars not equipped to control pollutant emissions. Partial control of carbon monoxide and hydrocarbon emissions from new passenger cars and light trucks is now required by national standards established by the Secretary of Health, Education, and Welfare and first placed in effect in the 1968 model year.

1. *Particulate emissions.*—Particulate matter emitted in the form of smoke is the pollutant of primary interest in jet aircraft exhaust. This smoke is composed largely of fine particles of almost pure carbon having diameters of 0.6 micron or less. This combination of size and composition gives substantial light-scattering properties to the exhaust plume, which, viewed against a contrasting background, conveys a visual impression of smoke considerably out of proportion to the actual particulate content. The extent of aerosol emissions in the form of dispersed water droplets, unburned fuel, and soot particles is not totally reflected by the indices in table 1 because of possible sampling variations. This is a question which remains to be resolved. These variations could cause at least an order-of-magnitude error in the turbine engine particulate emission shown in table 1. The particulate matter emitted by piston engines consists primarily of carbon and lead compounds, fuel droplets, and other materials. Lead compounds account for about half of these emissions. The amount of lead in exhaust gases from piston engine aircraft was estimated from data on the organic lead antiknock content of aviation gasoline. Its form and character are assumed to be analogous to their counterpart in gasoline-fueled highway vehicles.

2. *Gaseous emissions.*—Carbon monoxide and hydrocarbons are the gaseous pollutants of primary concern in the exhaust of both turbine and piston aircraft. The emission indices reported in table 1 for piston aircraft were derived from data on motor vehicle gasoline piston engines and have not been verified by actual measurement. The difference in magnitudes reflects the different engine operating modes involved as well as the different air-fuel ratios employed for a given power mode.

Oxides of nitrogen are emitted by both power systems but at different levels during similar operational modes.

Sulfur compounds resulting from the presence of residual sulfur impurities in fuels are present in very small quantities in the combustion products of motor vehicle and aircraft fuels. Consequently, they are of only minor concern in the transportation-related air pollution problem and are not shown in table 1.

Oxygenated organic compounds are being examined to determine their role in the formation of photochemical smog and their contribution to diesel exhaust odors.

TABLE 1.—COMPARISON OF POLLUTANT EMISSION INDICES FOR AIRCRAFT AND AUTOMOBILE ENGINES

Engine	Operating mode	Emission index: pound pollutant per 1,000 pounds fuel			
		CO	Hydrocarbons	NO _x	Particulates
Turbofan medium range jet	Idle and taxi	50	9.6	2.0	0.6
	Approach	6.6	1.4	2.7	2.7
	Takeoff	1.2	0.6	4.3	2.5
Radial	Idle	600	160	0	2
	Approach	800	60	5	2
	Takeoff	1,250	190	0	2
Piston					
Transport					
Average automobile engine * without emission control modes.		405	71	21	2

* See reference (6) on p. 31.

3. *Odors.*—The operation of turbine-powered aircraft produces certain characteristic odors, but at this time it is not possible to relate these odors to the specific chemical compounds or classes of compounds isolated from samples of turbine exhaust.

B. ANALYTICAL TECHNIQUES

Measurement technology applicable to exhaust from jet aircraft, particularly that which is applicable to the characterization of smoke and odor, is still in the early stages of development. Consequently, available procedures are not altogether appropriate for evaluating the emission characteristics of concern, and considerable uncertainty exists concerning the validity, precision, and reproducibility of the techniques which are used. To help correct this deficiency, a committee has been set up by the Society of Automotive Engineers (SAE) "to establish standard methods, apparatus, and techniques for determining and measuring the constituents of the exhaust of aircraft engines." Through the activities of this committee, the experience of various organizations that have been making such measurements for their own purposes will be utilized to formulate procedures which can be uniformly applied. This will greatly facilitate future studies of aircraft emissions and will permit the establishment of a better quantitative basis for finite assessment of their contribution to total community air pollution than is now available. The Departments of Health, Education, and Welfare; Transportation; and Defense are represented on the committee.

1. *Particulate emission measurement methodology.*—Quantitative data relating to aircraft particulate emissions have essentially been limited to determinations made by filtration of known volumes of ex-

haust and measurement of the weight of the deposit (7), (8). In some instances, notably in studies conducted by engine manufacturers, sample lines as long as 40 feet were used to deliver the exhaust sample to the filter head frequently at nonisokinetic rates, thus changing the flow rate of the exhaust stream. This practice is based on the questionable assumption that the total particulate content is of submicron size and will not be deposited in the lines. Such an assumption places considerable uncertainty on the data obtained by this method. These data may tend to understate the amount of particulate matter reaching the air in visible form. More rigorous sampling techniques, such as those employed in the Los Angeles studies (1), tend to give higher values. At this time, it is not possible to fully reconcile the disparity. Further studies are in progress in Los Angeles, but data from these studies were not available at the time this report was prepared. The development and use of smokeless turbine engines should control total particulates to such an extent that the current measurement differences will prove to be relatively unimportant. In the absence of corresponding data on aerosol composition, particle-size distribution, number, and refractive index, it is impossible to judge from data on weight alone the optical properties which determine the visual appearance of the smoke plume. Efforts to measure the obscuration of light by the plume, according to the standard Federal test procedure specified for assessing the visual appearance of diesel-engine exhaust plumes, have not been successful so far (9). The SAE committee is in the final stages of standardizing a system suitable for use in engine test cells; it is based on light reflectance measurements of filter paper stains resulting from the passage of known volumes of turbine exhaust. Further research will be required to establish a quantitative relationship between the visual appearance of the plume and the particulate content of the exhaust.

2. *Gaseous emissions measurement methodology.*—The similarity of the gaseous pollutants in aircraft and motor-vehicle emissions makes existing technology developed for measurement of motor-vehicle emissions applicable, in principle, to the measurement of the carbon monoxide, hydrocarbons, and nitrogen oxides in aircraft emissions. Problems of application exist, however, particularly in the sampling of the exhaust from piston aircraft, where combustion continues in the atmosphere beyond the exhaust ports.

3. *Odors.*—In the absence of specific knowledge concerning the chemistry of odors from jet aircraft, use of trained human subjects would be necessary to quantitatively assess the intensity or quality of these odors. Considerable research is in progress, partly under sponsorship of the National Air Pollution Control Administration, concerning the isolation and identification of materials responsible for odors in exhaust from diesel engines. Inasmuch as similar fuels are involved, it is expected that the information generated through diesel odor research will be translatable, at least in part, to odors from jet aircraft.

IV. BASIS OF EMISSION ASSESSMENT

A. AIRCRAFT POPULATION

1. *General aviation.*—General aviation (GA) is a broad category which includes all civil aircraft except those of the commercial air carriers. Its composition and projected growth are shown in figure 1.

In January 1967, there were 104,706 active, general aviation aircraft registered with the Federal Aviation Administration (10). The GA aircraft population, which constitutes 98 percent of the U.S. civil aircraft population, increased sharply in 1965 and is currently increasing by about 8,000 aircraft per year. This rate of increase is expected to continue for several years.

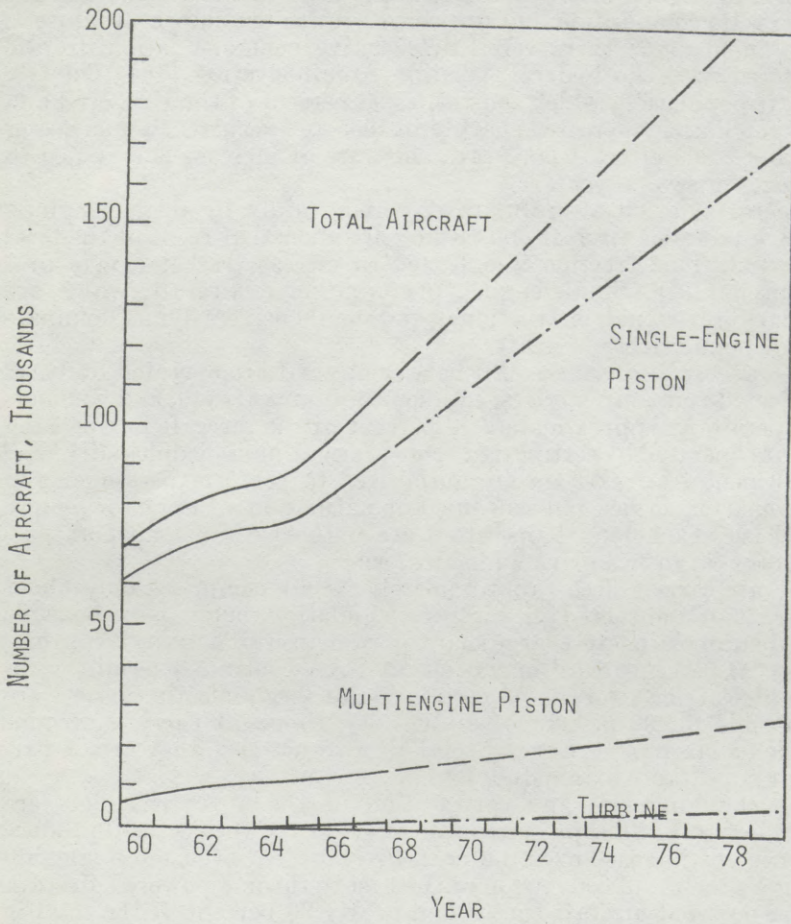
General aviation aircraft are powered mainly by piston engines. Turbine-powered aircraft constitute only about 1 percent of the total at present. This fraction is expected to increase rather slowly to 3 percent by 1979. Single-engine, piston-powered aircraft, which are popular for personal, instructional, and small business flying, dominate the GA population.

2. *Commercial carriers.*—Air carrier aircraft are operated by FAA certificated route air carriers, supplemental air carriers, and commercial operators. Approximately 90 percent of the aircraft in this category are operated by certificated route carriers, or "scheduled airlines." Supplemental air carriers are authorized to perform passenger and cargo charter service and scheduled operations on a limited or temporary basis. Commercial operators are authorized to transport passengers or cargo on a private for-hire basis.

The air carrier fleet (approximately 2,500) comprises only about 2 percent of the total U.S. aircraft population, but it is responsible for a disproportionately large share of total aircraft activity. Approximately 20 percent of all operations at FAA-controlled terminals involve air-carrier aircraft. At certain major terminals air carriers are responsible for 90 percent of all activity. Since air carriers account for such a large percentage of total aircraft activity, they are of particular importance to this study.

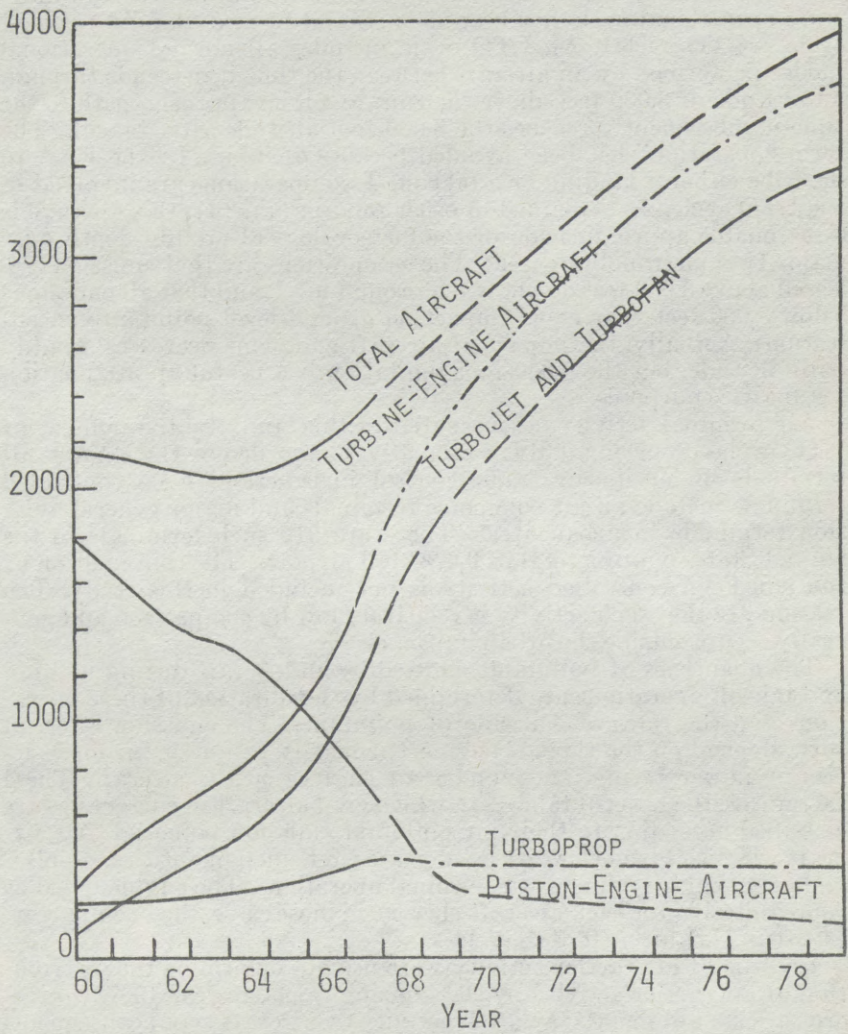
The changing size and composition of the air-carrier fleet are shown in figure 2. The projected rate of growth of the fleet will produce a 50-percent increase over the next 10 years. An even more striking change is the rapid conversion of the fleet to turbine-powered aircraft. Piston-powered aircraft constituted nearly 90 percent of the total in 1960, but now make up only 15 percent. This percentage will continue to diminish.

3. *Military aircraft.*—The aircraft inventory of the U.S. Department of Defense, as of December 31, 1967, consisted of 33,749 aircraft (12). For the most part, the dispersion of this aircraft inventory is outside the urban environment of concern in this study. It was therefore concluded that the military contribution is minor compared to the total activity. However, the military contribution at all FAA terminals is included in the activity data and subsequently in the emission data.



SOURCE: REFERENCE 11

FIGURE 1. COMPOSITION OF THE UNITED STATES GENERAL AVIATION FLEET



SOURCE: REFERENCE 11

FIGURE 2. COMPOSITION OF THE UNITED STATES AIR CARRIER FLEET

B. AIRCRAFT ACTIVITY

The aircraft activity of primary interest from an air pollution standpoint is that which occurs near air terminals. To facilitate analysis of pollutant emissions resulting from terminal activities, an aircraft operational cycle has been defined and termed "landing-takeoff cycle" (LTO cycle). An LTO cycle includes all normal operational modes performed by an aircraft between the time it descends through an altitude of 3,000 feet above the runway on its approach path to the time it subsequently reaches the 3,000-foot altitude after takeoff. The term "operation" has been avoided because of its use by the FAA to describe either a landing or a takeoff. Two operations are involved in one LTO cycle. As explained in other reports (1), (4), this altitude is a reasonable approximation of the meteorological mixing depth over major U.S. metropolitan areas. The assumptions are that emissions released above 3,000 feet do not reach ground level, and that all emissions below 3,000 feet have equal impact on ground-level pollutant concentrations. Actually, the impact of aircraft emissions decreases steadily with altitude, but the 3,000-foot limitation is a useful approximation for analysis purposes.

Air terminal activity, as measured in this study by the number of LTO cycles occurring daily or annually, is recorded by the FAA at all terminals under its air traffic control jurisdiction. FAA-controlled terminals include all air commerce terminals and major general aviation terminals in urban areas. There are 913 such terminals in the United States out of a total of 9,673 civil airports. The contribution of the non-FAA-controlled activity is not included in this study. The reasons are that such activity is relatively low by comparison and generally occurs outside the urban impact area.

The quantities of pollutants emitted by an aircraft during landing and takeoff operations are determined by the duration of these operations and the rates of emission of pollutants. The emission rates, in turn, depend on the type of engine (primarily piston or turbine), its size or power rating, and number of engines on the aircraft. These factors are the basis of table 2, in which civil aircraft in current use are classified according to their air pollutant emission potential. All aircraft within a given class are assumed to emit equal quantities of pollutants (per engine) during air terminal operations. The engine listed as representative for each aircraft class is, in most cases, the one in greatest use in U.S. aircraft of that class.

Records of air carrier activity were used to determine the distribution of air carrier activity by class during calendar year 1967. No records are kept of general aviation activity by aircraft type; consequently, all GA activity has been assumed to involve light, piston-engine (class 6) aircraft. Military activity at terminals in urban areas has been assumed, somewhat arbitrarily, to involve mainly turbine-engine aircraft (classes 3, 4, and 7), combined with a smaller number of piston-engine aircraft (classes 5 and 6). Estimates of average daily activity by aircraft class at three major air terminals, and at all FAA-controlled terminals combined, are listed in table 3.

TABLE 2.—AIRCRAFT CLASSIFICATION SYSTEM FOR ASSESSING EXHAUST EMISSIONS

Aircraft class	Aircraft type	Examples	Representative engine		
			Manufacturer and model	Type	Maximum thrust or power
1.....	Long-range jet transport.....	Boeing 707, Douglas DC-8.....	Pratt & Whitney JT3D.....	Turbofan.....	18,000 lb.-t.
2.....	Medium-range jet transport.....	Boeing 727, Douglas DC-9.....	Pratt & Whitney JT18D.....	Turbofan.....	14,000 lb.-t.
3.....	Business jet.....	Lockheed Jetstar, North American Sabreliner.....	Pratt & Whitney JT12.....	Turbojet.....	3,000 lb.-t.
4.....	Turboprop transport.....	Lockheed Electra, Fairchild Hiller FH-227.....	Allison 501-D13.....	Turboprop.....	3,750 eshp. ¹
5.....	Piston-engine transport.....	Douglas DC-6, Convair 440.....	Pratt & Whitney R-2800.....	Radial piston.....	2,500 hp.
6.....	Piston-engine utility.....	Cessna 210, Centurion, Piper 32-300, Cherokee 6.....	Continental 10-520-A.....	Opposed piston.....	285 hp.
7.....	Turbine-engine helicopter.....	Sikorsky S-61, Vertol 107.....	General Electric CT58.....	Turboshaft.....	1,400 hp.

¹ Equivalent shaft horsepower.

TABLE 3.—AIRCRAFT ACTIVITY BY CLASS

Area.....	Average number of LTO cycles per day in 1967							
	Aircraft class ¹							
	1	2	3	4	5	6	7	Total
J. F. Kennedy Terminal.....	256	183	1	49	13	105	53	660
Washington National Terminal.....	3	132	3	123	69	127	0	457
Los Angeles International Terminal.....	263	156	7	45	17	126	46	660
Total Nation (913 FAA-controlled terminals).....	2,444	4,202	2,300	4,203	2,820	52,091	615	68,675

¹ Aircraft classes are as follows: 1, long-range jet; 2, medium-range jet; 3, business jet; 4, turboprop transport; 5, piston-engine transport; 6, piston-engine utility; 7, turbine-engine helicopter.

Sources: References (13), (14), and (15).

C. FUEL CONSUMPTION

The rates of emission of air pollutants by aircraft engines, as with other internal combustion engines, are related to the fuel consumption rate. Other factors influence pollutant emission rates, of course, but for purposes of this study, engines of the same type operating at similar conditions will be assumed to emit pollutants at rates directly proportional to their fuel consumption rates. Table 4 shows fuel consumption rates by aircraft class.

TABLE 4.—FUEL CONSUMED PER ENGINE DURING A LANDING-TAKEOFF CYCLE

Aircraft class	Aircraft type	Ground operations				Flight operations			
		Taxi and idle		Landing and takeoff		Approach and climbout		Total cycle	
		Duration (minutes)	Fuel consumed (pounds per engine)	Duration (minutes)	Fuel consumed (pounds per engine)	Duration (minutes)	Fuel consumed (pounds per engine)	Duration (minutes)	Fuel consumed (pounds per engine)
1	Long-range jet.....	13	236	1.4	195	5.8	577	20.2	1,008
2	Medium-range jet.....	13	199	1.1	120	4.9	338	19.0	657
3	Business jet.....	13	117	.8	35	2.1	69	15.9	221
4	Turboprop.....	13	127	.9	25	8.1	165	22.0	317
5	Piston transport.....	13	75	1.2	26	9.6	177	23.8	278
6	Piston utility.....	13	6	.7	1	6.3	7	14	14
7	Turbine helicopter.....	7	40	0	0	13.2	136	20.0	176
								20.2	

Note: LTO-cycle includes all normal operations below 3,000 feet above runway. Assumed conditions: (a) runway at sea level; (b) zero runway slope; (c) temperature 60° F.; (d) zero wind; (e) aircraft at maximum load.

V. DERIVATION OF EMISSION FACTORS AND EMISSION ESTIMATES

A. CURRENT ESTIMATES

Table 5 shows aircraft emission data derived for the average LTO cycle for the seven classes of aircraft. Emission indices and fuel consumption rates must be regarded as approximate, since the data were obtained from a number of different sources. For turbine engines, emission data were obtained from engine manufacturers. For aircraft piston engines, only a limited amount of direct emission data was available; automobile emission data for comparable operating modes were used to supplement the aircraft data, where necessary. Fuel-flow rates per engine for each operating mode were provided by industry sources. The appendix to this report will discuss the derivation of these data more fully and provide estimates of the degree of error in each case. While the information in table 5 represents the best estimates available at this time, it must be recognized that the specific engines tested may not have been truly representative of their respective classes and that there is wide variation in the results obtained by using different measuring techniques.

The emissions data presented in table 5 were combined with the 1967 aircraft activity data presented in table 3 to develop the estimates of average daily emissions shown in table 6 for several selected air terminals characterized by relatively high daily activity and for the entire Nation.

TABLE 5.—AIRCRAFT EMISSIONS DURING AN LTO-CYCLE

Aircraft class (engines/aircraft) ¹	Operations ²	Emissions (lb./aircraft/LTO-cycle)			
		CO	Organics	NO _x	Particulates
1.....	Ground.....	164.3	70.7	5.24	0.80
(4)	Flight.....	11.2	19.0	8.00	2.00
	Total.....	175.5	89.7	13.24	2.80
2.....	Ground.....	27.3	5.4	2.46	1.13
(2.7)	Flight.....	3.2	.9	3.32	2.35
	Total.....	30.5	6.3	5.78	3.48
3.....	Ground.....	83.7	8.1	2.34	.12
(6)	Flight.....	3.7	.2	1.32	.18
	Total.....	87.4	8.3	3.66	.30
4.....	Ground.....	9.0	3.1	1.54	.28
(2.8)	Flight.....	.9	.9	1.40	.42
	Total.....	9.9	4.0	2.94	.70
5.....	Ground.....	298.0	35.8	.66	.60
(3)	Flight.....	613.0	86.4	.54	1.05
	Total.....	911.0	122.2	1.20	1.65
6.....	Ground.....	8.9	.9	.03	.03
(1.4)	Flight.....	9.9	1.0	.03	.03
	Total.....	18.8	1.9	.06	.06
7.....	Ground.....	9.4	.9	.16	.16
(2)	Flight.....	1.9	.1	.98	.42
	Total.....	11.3	1.0	1.14	.58

¹ Number of engines per aircraft based on national averages. Class 3 aircraft activity consists primarily of military aircraft. 1 military engine is equivalent to 6 civil engines.

² Ground operations include idle, taxi, takeoff, and landing modes. Flight operations include approach and climboff modes below 3,000 feet.

B. FUTURE TRENDS

Some changes in the nature and extent of aircraft exhaust emissions in future years will occur as a result of changes in aircraft activity levels and changes in equipment. The effects of these changes cannot be predicted accurately; however certain impending changes can be identified and their probable effects noted. The increases in pollutant emissions will still be of small proportion to the total inventory in 1980 though higher than current percentages. This trend is due to the advent of control techniques for other sources, e.g., impact of the 1968 and 1970 motor vehicle standards for HC and CO. Though applied technology will generally reduce individual aircraft emissions of particulates, hydrocarbons, and carbon monoxide, increased activity will yield net increases in overall pollutant emissions. These trends are shown in table 7.

Activity levels are expected to increase in all aviation categories at the rate of approximately 10 percent per year. Peak-hourly rates will not follow the same trend at major air terminals due to limitations on activity levels of conventional, fixed wing aircraft. Limitations on LTO-cycle frequency have been imposed on several major terminals by the FAA for safety reasons but it is difficult to predict the long-term frequency pattern.

Decreased use of piston-engine transport aircraft (class 5) will gradually eliminate the largest individual sources of carbon monoxide and hydrocarbon emissions among aircraft. These will be replaced with current models of turbine-engine aircraft, mostly of the class 2 category. The principal effects of this conversion on emissions from this class will be a decrease in carbon monoxide and hydrocarbon emission and an increase in nitrogen oxides emission during operations at air terminals.

TABLE 7.—COMPARISON OF ALL 1967 CIVIL AIRCRAFT EMISSIONS TO 1979 CIVIL AIRCRAFT EMISSIONS AT ALL FAA-CONTROLLED TERMINALS

	Pollutant							
	Carbon monoxide		Hydrocarbons		Nitrogen oxides		Particulates	
	1967	1979	1967	1979	1967	1979	1967	1979
Civil aircraft emissions (million tons per year).....	0.80	1.27	0.13	0.24	0.014	0.058	0.006	0.014
Percent increase.....		59		85		300		133

¹ Military activity not included in computation of relative projections.

New super-size transport aircraft, such as the Boeing 747, Lockheed 1011, and McDonnell-Douglas DC-10, are expected to be in service in the early 1970's. Fuel consumption rates for these aircraft will be 30 to 40 percent greater than those for current transport aircraft; pollutant emissions are not, however, expected to increase proportionately. Current efforts by engine manufacturers to reduce exhaust plume visibility are expected to result in a reduction in particulate emission by individual aircraft (21). Other design changes to be in-

corporated in the jumbo jet engines should result in reduced carbon monoxide and organic emissions (21). On the other hand, emissions of oxides of nitrogen by the new aircraft are expected to increase.

There is a trend in the production of general aviation aircraft toward increased use of turbocharged piston engines to provide greater takeoff power and higher altitude capability. Carbon monoxide and hydrocarbon emission rates are greater for turbocharged engines at takeoff conditions. Consequently, emission of these pollutants by general aviation aircraft during the LTO cycle is expected to increase.

These effects on the trend of emissions by broad aircraft classification are shown in Figure 3.

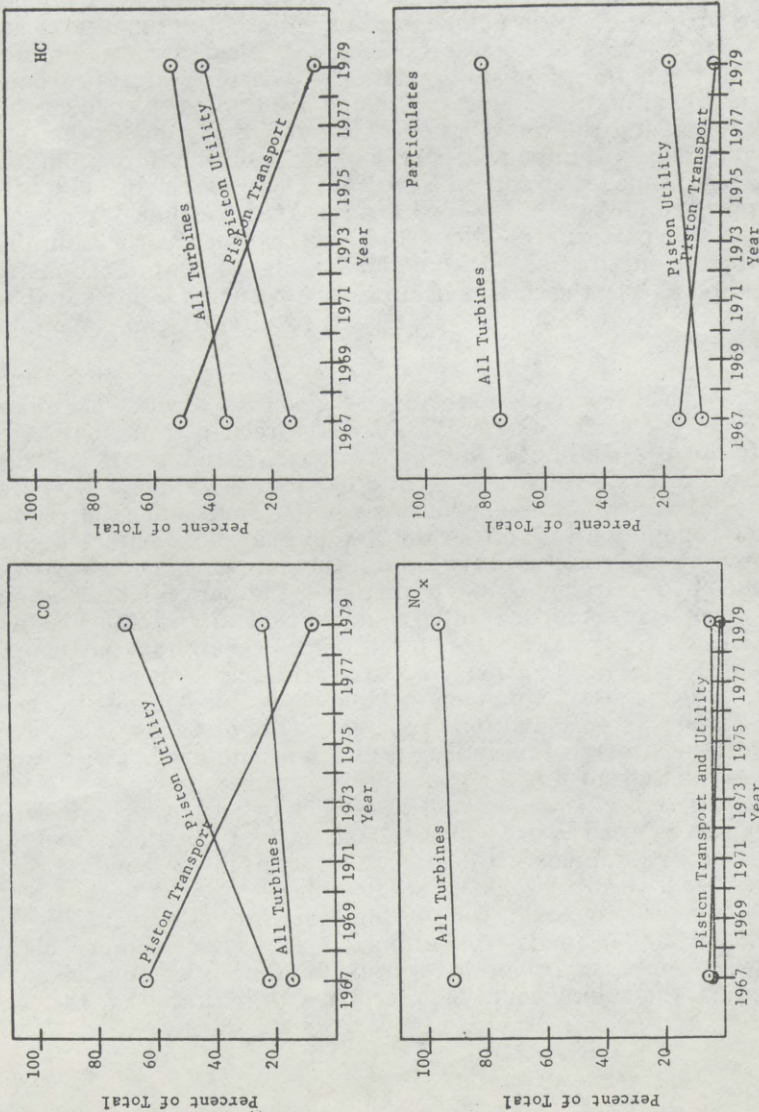


Figure 3. TRENDS IN POLLUTANT EMISSIONS BY DIFFERENT AIRCRAFT TYPES AT ALL FAA CONTROLLED TERMINALS FOR 1967-1979 (CIVIL AIRCRAFT ONLY)

VI. EFFECTS OF AIRCRAFT EXHAUST EMISSIONS

A. IMPACT ON AIR QUALITY

1. *Field measurements.*—Since aircraft emissions are similar to emissions from other transportation vehicles as well as other air pollution sources, there is no unique gaseous pollutant indigenous to aircraft which can serve as a tracer. Consequently, field measurements are of limited value for establishing mixing patterns for aircraft exhaust in the surrounding urban atmosphere and are limited in their usefulness for assessing the contribution of aircraft emissions to the community burden. A limited field survey of air pollution in communities around the Kennedy Airport in New York City was conducted by the Department in 1964 (22). The report of the study concluded "that concentrations of particulates, odors, and hydrocarbons at the sampling stations were substantial and came from many sources in the metropolitan area. Thus, the small variations that occurred in measured air quality were not significantly correlated to aircraft emissions on a statistical basis."

2. *Comparison of emission rates.*—Since aircraft emissions cannot be distinguished from emissions from other sources when all are mixed together in the community atmosphere, the relative contribution of aircraft can be determined only by comparing estimates of emission rates from aircraft with rates from other sources. Table 6 compares estimates of aircraft emission rates with rates from other sources for three metropolitan areas and for the Nation as a whole. Aircraft emissions are seen to constitute between 0.1 and 1.3 percent of all carbon monoxide, hydrocarbons, oxides of nitrogen, and particulate emissions in the areas considered. It should be noted that the Los Angeles Air Pollution Control District has reported (4) a 1964 aircraft particulate emission rate of 4,380 tons per year from all aircraft operating in the county, while the estimate given in table 6 for Los Angeles International Airport is only 100 tons per year. This disparity is a direct result of the different analytical techniques employed, which were previously discussed.

3. *Comparison of emission densities.*—The impact of aircraft emissions can be assessed by comparing the density of emissions (tons/sq. mi./yr.) at air terminals with emission densities in surrounding communities. Such a comparison is shown in table 8.

With few exceptions, this comparison indicates that the densities of emissions at air terminals from aircraft are generally comparable to densities of emissions from other sources in adjacent communities. In this context, the values would be interpreted to indicate that the con-

tribution made to the community by aircraft activity is probably negligible. In some instances the airport may possibly act as a small sink for the dilution of the near community emissions.

There is a definite need for continuous monitoring of airport environments in order to assess the transient effects of highly variable activity. Peak emission densities for CO could possibly be as much as 20 times the average based on estimates made by Northern Research. The impact of such peak rates relative to employees and passengers in the terminal environment remains to be determined.

TABLE 8.—DENSITY OF AIRCRAFT EXHAUST EMISSIONS AT AIR TERMINALS COMPARED WITH EMISSIONS IN SURROUNDING REGIONS

Emission area	Average emission density in 1967 (tons per square miles per day)				
	Land area (square miles)	Carbon monoxide	Hydro- carbons	Nitrogen oxides	Particu- lates
New York ¹	189.0	14.1	4.0	2.9	0.83
Kennedy International Terminal ²	4.5	6.1	2.2	.2	.06
Virginia-Washington, D.C. ³	103.0	15.4	3.5	1.7	.52
Washington National Terminal ²	.9	15.0	2.2	.3	.11
Los Angeles Basin	1,250.0	8.1	2.2	.6	.08
Los Angeles International Terminal ²	3.0	9.3	3.7	.3	.09

¹ Kings and Queens Counties.

² Aircraft emissions for entire LTO-cycle.

³ District of Columbia, Arlington County, and Alexandria City, Va.

4. *Calculations of concentrations in aircraft cabins.*—During taxiing, idling, and even during takeoff, an aircraft may be directly exposed to the exhaust of a preceding craft. Diluted exhaust can be drawn into the cabin through the ventilating system, as is occasionally evidenced by the presence of exhaust odors in the cabin. In the absence of actual measurements of cabin concentrations under such conditions, calculations were made of carbon monoxide concentrations in the wake of taxiing aircraft. For a long-range jet transport, taxiing at a speed of 5 m.p.h. the concentration within a wake area of 100 square meters was calculated to be approximately 350 p.p.m. For a wake having an area of 500 square meters, the calculated concentration was 75 p.p.m. These values indicate the potential source concentrations which could effect cabin environments.

B. PUBLIC REACTION

Concern over the adverse effects of aircraft operations on the environment has risen concurrently with the growth of air transportation. Conversion of the air carrier portion of the air transport fleet to turbine-powered aircraft has markedly increased the degree of expressed public concern about vibration, noise, and air pollution. The jet's air contaminant emissions are more visible and more characteristically odorous than those of even the largest piston-engined air transports. The clustering of engines and exhausts in some modern jet aircraft serves to increase the apparent opacity of the plume.

Public concern about air pollution from aircraft is evidenced by complaints made to airport officials and air pollution control agencies, by newspaper reports, and by citation of aircraft emissions as a cause of concern by authors of related technical articles. The complaints

of record, when specific, tend to cite the visible plume, more frequently than odor, as a cause of concern. The aircraft industry's current activity aimed at the development of turbine engines which will emit less visible smoke reflects the public's reaction to aircraft smoke plumes. To most people visible emissions are symbolic of the air pollution problem; indeed, the two are frequently equated. The sight of smoke plumes from any source seems to suggest to many people that officials charged with controlling air pollution are guilty of inaction.

C. IMPACT ON ADJACENT LAND USE

In many cases airports have had an adverse effect on residential land use, lowering property values and inhibiting high density development. The latter effect is attributable to the potential hazard associated with aircraft operation. The decline in property values is the result of a general environmental degradation. The extent of the role which air pollution from aircraft and airport operation plays in this degradation has not been specifically determined. Generally the decline in property values has been attributed to the other more easily perceptible forms of environmental "pollution," i.e., noise and vibration.

Techniques for evaluating the effect of noise pollution associated with aircraft operation seem relatively well developed. Noise contours can be determined for each runway, community noise complaint patterns established, and land uses categorized according to their compatibility with different acoustical and vibration levels. The same degree of sophistication has not been extended to examining either the existent or potential impact on air quality caused by airport operations.

D. IMPACT ON METEOROLOGY

This report deals primarily with emissions from aircraft into the layer of the troposphere deemed to be associated with urban air pollution and assumed to be that portion below the 3,000-foot level. The subject of pollutant emissions into the atmosphere at higher levels raises interesting possibilities pertaining to worldwide air pollution and to the consequences of high-level contamination on the earth's meteorology. The total aircraft pollution contribution is about three times the emission levels estimated in table 6 which cover only operations below 3,000 feet. This altitude was the assumed average boundary layer which would limit the transport of pollutants released in the upper atmosphere to the surface environment. The role of particulate matter as a source of nucleation and its effect on precipitation is well recognized and is being employed in weather modification programs at the local level. The importance of high-level pollutant emission on worldwide meteorology including precipitation, isolation, light refraction, heat dissipation, and interactions with the ozonesphere remains to be defined.

VII. ENGINE AND FUEL PARAMETERS AFFECTING EMISSIONS AND THEIR CONTROL

A. AIRCRAFT ENGINES

Aircraft engines fall into two basic categories—reciprocating or piston engines, and gas turbines. The exhaust gases from aircraft piston and turbine engines are distinctly different. A turbine engine operates at air-fuel ratios five to 20 times greater than piston engine air-fuel ratios. Consequently, exhaust concentrations of all combustion products from turbine engines are correspondingly lower. In addition, because of differences in fuels and combustion chamber characteristics, the total quantities of pollutants emitted are different. The differences were indicated in Table 1 which presents emission indices for several categories of pollutants and for turbine and piston engines utilized in large transport aircraft.

1. *Turbine engines.*—There are four basic types of gas turbine engines used for aircraft propulsion: turbojet, turboprop, turboshaft, and turbofan. The basic element common to all four is the gas turbine, consisting of a compressor, a combustion chamber, and a turbine. Air entering the forward end of the engine is compressed and then heated. The major portion of the energy in the heated air stream is used for aircraft propulsion. Part of the energy is expended in driving the turbine which, in turn, drives the compressor.

Smoke from jet aircraft originates in the gas turbine combustors because of the presence of local over-rich fuel-air mixtures close to the point of fuel injection. Heat transferred to these regions of the combustor from the flame causes chemical reactions leading to the formation of free carbon, some of which survives the combustion process and is emitted to the atmosphere as particulate matter, which manifests itself as smoke (21).

Efforts are in progress by the manufacturers of aircraft gas turbines to redesign the combustors to eliminate these local over-rich regions. The results of some of these redesign efforts are shown by the photographs in figures 4 and 5. Figure 6 (21) shows graphically what is obtainable with combustion modification.

During all flight operations, the concentrations of carbon monoxide and hydrocarbons in turbine engine exhausts are very low. During ground operations (idle and taxi), however, these concentrations increase by factors of from 50 to 100. Concentrations of nitrogen oxides and particulates, on the other hand, are greater during flight operations, though the variation is not nearly so great as with carbon monoxide and organic emissions.

Carbon monoxide, like particulate carbon, is believed to originate in local over-rich zones in engine combustors. Hydrocarbons result from premature quenching of combustion reactions near the combustor walls, due to local injection of air to cool the wall (21). The changes in combustor design being introduced for the purpose of controlling smoke may also result in reduced hydrocarbon emissions. Another approach which could be taken with future engines is to employ combustor designs which achieve the least possible surface area for a given total combustor volume. These "annular combustors" would require proportionately less cooling air and hence would offer less opportunity for local flame quenching to result in hydrocarbon and carbon monoxide emissions.



Boeing 727 on takeoff, powered by Pratt & Whitney Aircraft JT-8-D engines. The lower photograph shows the marked reduction in smoke when the engines use modified combustors. This aircraft, with modified combustors, is currently undergoing service evaluation. There are six airlines currently performing these service evaluations.

Photograph by courtesy of Pratt & Whitney Aircraft, and Pacific Southwest Airlines.

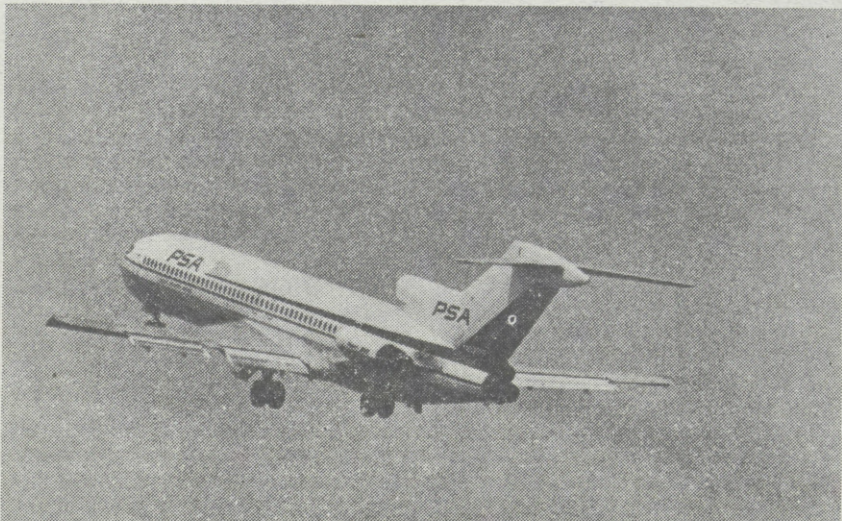
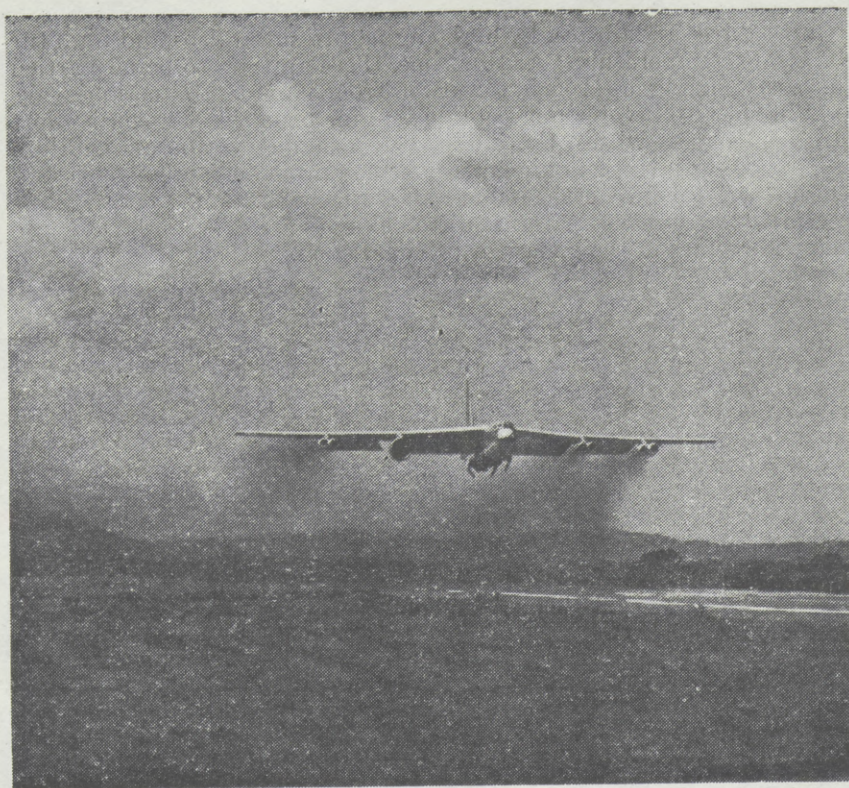


FIGURE 4



A B-52 aircraft, leased by Pratt & Whitney Aircraft from U.S. Air Force, was modified to permit flight testing of JT-9-D. Note the absence of smoke from the JT-9-D located under the right wing at inboard location.

Photograph by courtesy of Pratt & Whitney Aircraft.

FIGURE 5

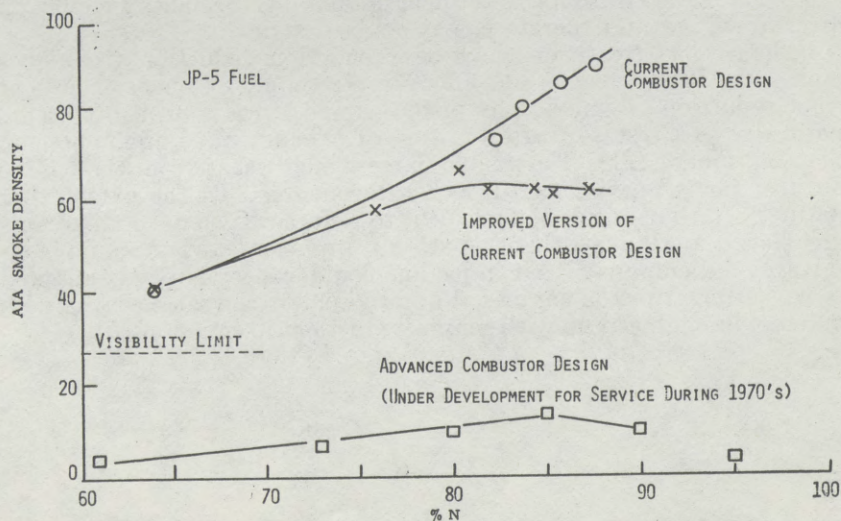


FIGURE 6. SMOKE EMISSION LEVELS OF COMBUSTOR FOR FAN ENGINE "B"

Formation of nitrogen oxides is favored by high combustion zone temperatures and, hence, by high engine pressure ratios and high turbine inlet temperatures. At this time, there appears to be no particularly promising approach toward nitrogen oxides reduction which would not also involve unacceptable engine penalties. Research efforts are in progress within the industry to examine various possibilities for reducing nitrogen oxides without compromising other aspects of engine performance or the reduction of other pollutants (21), (8).

2. *Piston engines.*—Aircraft piston engines are very similar to automobile engines in their manner of operation. The basic element is the combustion chamber, or "cylinder," in which fuel and air mixtures are burned and from which energy is extracted through a piston and crank mechanism that drives a propeller. Nearly all aircraft piston engines have two or more cylinders and are generally classified according to their cylinder arrangements. Two basic arrangements are in general use—the "opposed" and "radial" configurations. Opposed engines are installed in most light aircraft and are being used in increasing numbers. Radial engines are used mainly in large transport aircraft and are gradually being replaced by turbine engines.

During operations at air terminals, aircraft piston engines are operated at comparatively rich fuel-air ratios. This is particularly true during takeoff, when rich mixtures are required to obtain maximum power and to avoid engine knock and overheating. As a result, exhaust gases from aircraft piston engines contain comparatively high concentrations of carbon monoxide and organics and low concentrations of nitrogen oxides.

All of the emission control techniques applicable to automobile engines are applicable, in principle, to aircraft piston engines. The techniques vary widely, however, in practicability. In addition, unless future data dictate otherwise, controls may not be deemed necessary.

Engine design changes used to reduce emissions from automobile engines are based to some extent on the use of lower fuel-air ratios. Such changes could impose an unacceptable performance penalty on aircraft engines and, therefore, may not be practical.

Exhaust gas treatment may offer emission reduction techniques which are both feasible and effective. It should be mentioned that some reduction of emission by piston-engine aircraft probably occurs naturally as a result of afterburning of exhaust gases upon entering the atmosphere (21). The visible flame which issues from the engine exhaust ports is evidence of such afterburning. To the extent that natural afterburning is not sufficient to reduce emissions to an acceptable level, auxiliary exhaust port air injection devices could conceivably be employed. Air injection could conceivably be adapted to new aircraft piston engines at approximately the same cost as with automobile engines, and with similar reductions in emissions.

B. AIRCRAFT FUELS

Aircraft fuels, along with automotive fuels, are mixtures of liquid hydrocarbons obtained through refining of crude petroleum. There are two categories of aircraft fuels corresponding to the two types of aircraft engines. Piston engines use aviation gasoline, while turbine engines in civil and some military aircraft use aviation kerosene. Other military, turbine-engine aircraft are operated on a gasoline-kerosene blend.

Aviation gasoline, like automobile gasoline, is rated primarily in terms of its antiknock quality, or octane rating. Aircraft piston engines require octane numbers ranging from 80 to 145, which is a much wider range than that required by automobiles. The higher octane numbers are attained to some extent through the use of increased quantities of tetraethyl lead additive.

Aviation kerosene is not rated directly in terms of engine performance factors. There is no dominant problem in turbine engine combustors corresponding to knocking in piston engines, and so, turbine engine fuels need not and do not contain lead. These fuels are rated in terms of smoke-forming tendencies, however, and limits are imposed on this characteristic in fuel specifications. The formation of carbon in turbine engines, which produces smoky exhaust trails, results from the decomposition of certain organic compounds in fuel-rich zones in the engine combustion chambers. Of the various constituents of turbine-engine fuels, aromatic hydrocarbons have been shown to be the most prone to carbon formation. Consequently, the concentration of aromatics is limited to 25 percent for volume in most fuel specifications. This limit has been imposed to reduce engine deposits and to improve component durability, rather than to reduce exhaust smoke, but it is an indication that carbon formation is considered in the formulation of fuel specifications.

Particulate emissions (or smoke) from aircraft turbine engines could be noticeably reduced by limiting aromatic fuel constituents to very low levels, or by specifying highly paraffinic and more volatile fuels. These changes, however, are generally very costly, and, in some cases, might result in increased fire hazards.

Another approach to reducing smoke emission by turbine engines involves the use of additives. Experimental tests with different materials have revealed that certain metal compounds, when added to the fuel in low concentrations, are effective in reducing smoke. But products of combustion of the additive materials are found to cause engine performance to deteriorate rapidly. Moreover, the effects that emissions of these additive materials would have on the community atmosphere are also largely unknown. Because of these factors, smoke-reducing additives are not considered practical for general use in turbine engines (21).

Basically, no changes in fuel characteristics having any significant effect on pollutant emissions from turbine engines can be antici-

pated in the foreseeable future. The next generation of transport (including supersonic aircraft) and general aviation aircraft is expected to utilize fuels similar to those in current use.

Particulate lead compound emissions from aircraft piston engines could be reduced, in the case of automobile engines, by reducing the lead content of gasoline. Low-lead or lead-free gasoline suitable for automobile engines could, no doubt, be made available at a price for small aircraft piston engines, but special fuels might have to be developed for high-performance aircraft piston engines.

In principle, use of nonpetroleum fuels, such as ammonia or hydrogen, would eliminate emissions of carbon monoxide, organics, and carbon. Use of fuels having inherently lower flame temperatures than do hydrocarbons—alcohols, for example—might even reduce nitrogen oxides formation. Conversion to such fuels, however, would present enormous problems in production, storage, and handling, as well as in cost and safety. For these reasons, nonhydrocarbon fuels cannot be considered practical for emission reduction, at least in the near future.

VIII. INTERACTIONS BETWEEN AIRCRAFT SAFETY, NOISE, POLLUTANT EMISSION, AND EMISSION CONTROL

There are three aspects of aircraft operations which are of concern to the public and to Government regulatory agencies. These are safety, noise, and air pollution. It is essential that safety and noise not be degraded as a result of any program designed to control air pollution emissions.

A. INTERACTIONS BETWEEN POLLUTANT EMISSIONS AND SAFETY

Possible interactions between pollution emissions and aircraft safety support a positive program of emissions control. Excessive smoke emissions tend to reduce visibility at the end of runways; excessive emissions of carbon monoxide and odor-causing compounds could impair the performance of the flight crew.

B. INTERACTIONS BETWEEN POLLUTANT CONTROL AND SAFETY

1. Turbine engines

(a) *Engine modifications.*—At the present time, only combustor design modifications are thought to be a practical approach to turbine emission control; it is now accepted that low-smoke combustors can be designed without a significant penalty on performance or relight capability (21).

(b) *Fuel additives.*—Use of fuel additives as smoke suppressants tend to result in engine deposits which could impair the performance and reliability of the engine over long periods of operation.

(c) *Volatile fuels.*—The use of high volatility and nonhydrocarbon fuels (e.g., hydrogen) constitutes a greater probable fire hazard than the use of current aviation fuels.

2. Piston engines

(a) *Engine modifications.*—Certain engine modification approaches to emission reduction, of the type employed in automotive engines, are considered to be impractical as they would tend to degrade engine performance and, possibly, safety.

(b) *Exhaust gas treatment.*—Exhaust gas treatment, which has been proven to be effective in automobile engines, should be equally applicable to aircraft engines, without affecting performance or safety.

(29)

C. INTERACTIONS BETWEEN POLLUTANT CONTROL AND NOISE ABATEMENT

The rate of pollutant emission for a given engine at a constant thrust setting is not related to the noise generated. Therefore, changes to the combustion chamber aimed at reducing emissions will not influence the noise emitted. The need to reduce thrust settings during climb out from airfields to comply with local noise abatement procedures results in a reduction of pollutant emissions but an increase in time spent in climbing to 3,000 feet. These effects are mutually compensating, so that changes in the total quantities of pollutant emitted, when satisfying local noise abatement requirements, are negligible.

D. GROUND OPERATIONS

Ground operations are responsible for a major portion of the emissions of carbon monoxide, hydrocarbons, and odor-causing components in aircraft emissions during an LTO cycle. Table 9 shows the proportions of the pollutants emitted during this phase of the cycle. The curtailment of ground operations and new airport design concepts aimed at emissions control should not have an adverse effect on safety and should contribute to a reduction in noise.

TABLE 9.—PERCENTAGE OF LTO-CYCLE EMISSIONS PRODUCED DURING GROUND OPERATIONS¹

Emission area	Pollutant			
	Carbon monoxide	Hydrocarbons	Nitrogen oxides	Particulates
Kennedy Airport.....	82.8	75.9	41.3	34.1
Washington National Airport.....	69.6	65.3	49.3	39.9
Los Angeles International Airport.....	81.3	74.4	42.0	34.7
Total of national FAA-controlled airports.....	55.4	55.7	49.7	46.4

¹ Weighted according to activity levels of aircraft classes 1-7 at various terminals and metropolitan areas during taxi, idle, landing and takeoff operations.

Source: Derived from tables 3 and 5, this report.

REFERENCES

1. George, R. E. and Burlin, R. M. "Air pollution from commercial jet aircraft in Los Angeles County." Air Pollution Control District, Los Angeles, California. April 1960.
2. "Report of the program study group on aircraft exhaust." Aviation Fuel, Lubricant, and Equipment Research Committee of the Coordinating Research Council, Inc. August 1960, revised December 1960.
3. "Clean air." Hearings before a Special Subcommittee on Air and Water Pollution of the Committee on Public Works, U.S. Senate, 88th Congress, 2nd Session, Part 2, U.S. Government Printing Office, Washington, D.C. 1964.
4. Lemke, E. E., Shaffer, N. R., Verssen, J. A., and Lunche, R. G. "Air pollution from aircraft in Los Angeles County." Air Pollution Control District, Los Angeles, California. December 1965.
5. "Air pollution—1967 (Automotive air pollution)." Hearings before the Subcommittee on Air and Water Pollution of the Committee on Public Works, U.S. Senate, 90th Congress, 1st Session, Part 1, U.S. Government Printing Office, Washington, D.C. 1967.
6. "The automobile and air pollution: A program for progress." Report of the subpanel on current automotive systems to the panel on electrically powered vehicles. U.S. Department of Commerce. December 1967.
7. Shaffernocker, W. and Stanforth, C. "Smoke measurement techniques." Society of Automotive Engineers. (Air transportation meeting, May 1968, preprint No. 680346.)
8. Durant, T. "The control of atmospheric pollution from gas turbine engines." Society of Automotive Engineers. (Air transportation meeting, May 1968, preprint No. 680347.)
9. Faitani, J. J. "Smoke reduction in jet engines through burner design." Society of Automotive Engineers. (Air transportation meeting, May 1968, preprint No. 680348.)
10. "FAA statistical handbook of aviation." Federal Aviation Administration. November 1967. (1967 Edition) (also previous editions.)
11. "Aviation forecasts, fiscal years 1968–1979." Federal Aviation Administration. January 1968.
12. Direct communication. Office of the Assistant Secretary of Defense, Installations and Logistics. June 27, 1968.
13. "FAA air traffic activity, calendar year 1967." Federal Aviation Administration. February 1968.
14. "Airport activity statistics of certificated route air carriers, 12 months ended December 31, 1967." Civil Aeronautics Board and Federal Aviation Administration. September 1968.

15. "Military air traffic activity report, calendar year 1967." Federal Aviation Administration. July 1968. (also previous editions.)
16. "Air pollution data for Los Angeles County." Air Pollution Control District, Los Angeles, California. January 1967.
17. "New York-New Jersey air pollution abatement activity—sulfur compounds and carbon monoxide." U.S. Department of Health, Education, and Welfare, Public Health Service, National Center for Air Pollution Control, Cincinnati, Ohio. January 1967.
18. "New York-New Jersey air pollution abatement activity—Phase II—particulate matter." U.S. Department of Health, Education, and Welfare, Public Health Service, National Center for Air Pollution Control, Cincinnati, Ohio. December 1967.
19. "Washington, D.C. metropolitan area air pollution abatement activity." U.S. Department of Health, Education, and Welfare, Public Health Service, National Center for Air Pollution Control, Cincinnati, Ohio. 1967.
20. Hochheiser, S. and Lozano, E. R. "Air pollution emissions from jet aircraft operating in New York Metropolitan Area." Society of Automotive Engineers. April 1968. Paper No. 680339.
21. "Summary status report on aircraft engine exhaust emissions." Air Transport Association and Aerospace Industries Association. September 1968.
22. Nolan, M. "Air pollution around the John F. Kennedy International Airport." U.S. Department of Health, Education, and Welfare, Public Health Service, Division of Air Pollution, Cincinnati, Ohio. June 1966.



APPENDIX B

91ST CONGRESS }
1st Session }

SENATE

{ DOCUMENT
No. 91-10

AIR POLLUTION ABATEMENT BY
FEDERAL FACILITIES

SECOND REPORT
OF THE
SECRETARY OF HEALTH, EDUCATION,
AND WELFARE
TO THE
UNITED STATES CONGRESS
PURSUANT TO
Public Law 90-148
THE AIR QUALITY ACT OF 1967

JANUARY 1969



MARCH 4, 1969.—Ordered to be printed

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1969

25-140 O

SENATE RESOLUTION 88**Submitted by Mr. Randolph of West Virginia**

IN THE SENATE OF THE UNITED STATES,
Agreed to March 4, 1969.

Resolved, That there be printed with illustrations as a Senate document the report of the Secretary of Health, Education, and Welfare, entitled "Air Pollution Abatement by Federal Facilities" submitted to the Congress in accordance with section 306, Public Law 90-148, the Air Quality Act of 1967, and that there be printed two thousand five hundred additional copies of such document for the use of the Committee on Public Works.

FRANCIS R. VALEO,
Secretary.

(II)

LETTER OF TRANSMITTAL

THE SECRETARY OF HEALTH, EDUCATION, AND WELFARE,
Washington, D.C., January 17, 1969.

HON. HUBERT H. HUMPHREY,
President of the Senate,
Washington, D.C.

DEAR MR. PRESIDENT: In accordance with the provisions of title I, section 111(b) of Public Law 90-148 (the Air Quality Act of 1967), I am pleased to transmit the report on measures being taken by Federal agencies to control the emission of air pollutants from Federal facilities.

It is the intent of this report to describe in detail such progress as has been made toward controlling air pollution from sources for which Federal departments or agencies have jurisdiction.

Sincerely,

WILBUR J. COHEN,
Secretary.

(III)

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AIR POLLUTION ABATEMENT BY FEDERAL FACILITIES

I. INTRODUCTION

The Air Quality Act of 1967, as did the earlier Clean Air Act, as amended, emphasizes the need for Federal leadership and assistance to State and local agencies in the control of air pollution. The act also indicates that the Federal agencies shall cooperate with the Department of Health, Education, and Welfare and with any air pollution control agency in preventing and controlling air pollution. It also provides, at the discretion of the Secretary, for the establishment of classes of air pollution sources for which limited permits could be issued, and it further requires the Secretary to submit an annual report to the Congress on the status of such permits and compliance therewith.

In addition to this act, the program of abatement and control of air pollution from Federal facilities is governed by Executive Order 11282, dated May 26, 1966, entitled, "Control of Pollution Originating From Federal Installations"; the "Performance Standards and Techniques of Measurement" prescribed by the Secretary of Health, Education, and Welfare, issued June 2, 1966, and subsequently amended, in response to "Section 5 Standards" of Executive Order 11282; Bureau of the Budget Circular No. A-78 issued on August 6, 1966, to the heads of executive departments and establishments.

The issuance of limited exemptions, as provided under the Executive order, has been used as a control device, rather than development of a permit system, as authorized in the Air Quality Act of 1967.

The staff of the Federal Facilities Section, National Air Pollution Control Administration, devotes full time to the surveillance of air pollution problems arising from Federal activities, the extension of technical assistance to agencies and departments and to studies for scheduling necessary improvements to control emissions from Federal establishments. This staff also assists the Bureau of the Budget in technical and administrative review of the 5-year phased and orderly plans prepared by the various governmental groups concerned in this abatement activity.

II. ABATEMENT PLAN

As called for by Executive Order 11282 and Bureau of the Budget Circular No. A-78, the departments and agencies submitted revisions of their original phased and orderly plans on July 1, 1968, and also, for the first time, furnished reports of progress on projects which could be funded within available appropriations.

The revised plans are concerned principally with proposed abatement actions to be undertaken during fiscal year 1970. Appendix A contains the detailed proposals for abatement activities which have been recommended for funding by the Bureau of the Budget for fiscal year 1970.

On June 20, 1968, the Secretary of Health, Education, and Welfare announced that 32 Air Quality Control Regions would be designated during the next 12 months. These regions, in the order in which designation is expected to occur, are the following:

- | | |
|---------------------|--------------------------|
| 1. Washington, D.C. | 17. Hartford |
| 2. New York | 18. Indianapolis |
| 3. Chicago | 19. Minneapolis-St. Paul |
| 4. Philadelphia | 20. Milwaukee |
| 5. Denver | 21. Providence |
| 6. Los Angeles | 22. Seattle-Tacoma |
| 7. St. Louis | 23. Louisville |
| 8. Boston | 24. Dayton |
| 9. Cincinnati | 25. Phoenix |
| 10. San Francisco | 26. Houston |
| 11. Cleveland | 27. Dallas-Fort Worth |
| 12. Pittsburgh | 28. San Antonio |
| 13. Buffalo | 29. Birmingham |
| 14. Kansas City | 30. Toledo |
| 15. Detroit | 31. Steubenville |
| 16. Baltimore | 32. Chattanooga |

Under the Air Quality Act of 1967, designation of regions is a fundamental step leading toward action by State governments to adopt and enforce standards to control air pollution on a regional basis.

Once regions are designated, the Air Quality Act of 1967 requires that States set ambient air quality standards for the regions within 9 months following the publication of criteria for particular pollutants. An additional 6 months are allowed for the development of an implementing plan which would include emission standards for pollution sources. This standard-setting process is expected to begin in the first regions early in calendar year 1969.

Almost all of the Federal facility projects included in the President's budget for fiscal year 1970 are located in the 32 Air Quality Control Regions listed above. The funding of these projects will permit Federal facilities to provide leadership in abating air pollution in these regions.

A few additional projects are included in the President's 1970 budget because they are violations of local codes or are designated to abate toxic emissions which involve imminent danger to health. A project at one installation is included because of excessive complaints from the public.

III. EXEMPTIONS

The Department of Defense requested and was granted a 1-year exemption (to October 1, 1969) from the provisions of section 76.5, title 42, Code of Federal Regulations, part 76, dated March 17, 1967. This section required control of sulfur oxide emissions in the Chicago and New York Standard Consolidated Areas and the Standard Metropolitan Statistical Area of Philadelphia by October 1, 1968. It was impossible for the Department of Defense to meet this deadline with regard to a number of its facilities which require large capital expenditures for conversion of their boilers. The Department's fiscal year 1969 budget had progressed too far to allow the changes necessary to provide for these conversions. The President's fiscal year 1970 budget will allow the Department to undertake substantially all of these conversions.

The Atomic Energy Commission requested an exemption from the provisions of the same section requiring control of sulfur oxides in the New York and Chicago Standard Consolidated Areas for the Brookhaven and the Argonne National Laboratories, respectively. The request was based on the denial of funds by the Joint Committee on Atomic Energy for conversion to lower sulfur fuels at these laboratories. An exemption for 1 year (to October 1, 1969) has been granted to the Atomic Energy Commission for the Argonne and Brookhaven sites on the proviso that the Commission again request funds for fiscal year 1970 to convert the heating plant at Argonne to natural gas and that efforts be made to secure 1 percent sulfur fuel oil for Brookhaven.

The Joint Committee on Atomic Energy in its denial of funds for fiscal year 1969, urged a delay in the Argonne project pending an expected breakthrough on research which would produce an economically acceptable method of removing sulfur oxides from stack gases. Atomic Energy Commission representatives have been informed by the National Air Pollution Control Administration that the current research on developing control techniques for removing sulfur oxides from stack gases is directed to produce methodology suited for control of large fossil fuel-burning power-generating sources and not directed to heating plants as small as that at Argonne National Laboratory. This laboratory is within the boundaries of the Metropolitan Chicago Interstate Air Quality Control Region, which is identical to the Chicago Standard Consolidated Area. Since the region will be expected to have air pollution control standards and regulations within the next 15 months, a conversion of this facility now would be consistent with providing Federal leadership, as called for in Executive Order 11282.

The Department of Transportation requested, and was granted, a 1-year exemption for fuel conversion at the Coast Guard base on Governor's Island, N.Y. This base is partially converted to burn No. 2 distillate fuel oil, and the exemption was granted with the

proviso that conversion be completed as soon as additional funds become available. It is expected that this task will be completed before October 1, 1969.

Similarly, the Department of Agriculture requested an exemption from the sulfur-oxide regulation for the heating plant at the Plum Island, Long Island, Animal Disease Laboratory. A 1-year exemption also was granted in this case, on the proviso that the laboratory use the lowest possible sulfur content fuel oil which can be obtained from the General Services Administration for use at this site.

IV. REMEDIAL ACTIONS

Actions to abate air pollution from Federal facilities were reported this year, for the first time, to the Bureau of the Budget. As required by Bureau of the Budget Circular No. A-78, these reports arrived on July 1, 1968, and reflect conditions as of April 1, 1968.

A summary of these reports reveals that 442 remedial actions were reported for 387 installations located in 45 States, the District of Columbia, Puerto Rico, and Guam. With few exceptions, the remedial actions fall into the following categories:

1. Elimination of open burning of refuse.
2. Installation of new incinerators or upgrading of existing incinerators to meet Federal regulations.
3. Reduction of particulate emissions from heating and power plants by:
 - a. Repairs to old plants.
 - b. Construction of new plants.
 - c. Improvement of particulate collectors.
 - d. Installation or improvement of particulate monitors.
 - e. Conversion from coal to either gas or fuel oil.
4. Reduction of sulfur oxide emissions from heating plants by:
 - a. Using same type of fuel but of lower sulfur content.
 - b. Converting to a different fuel of lower sulfur content.
5. Reduction of gasoline and solvent vapor losses from storage tanks.
6. Awarding of contracts during the year to remedy specific situations.
7. Initiation of studies, design and/or engineering actions to prepare cost estimates.

Appendix B presents an overall summary of accomplishments by agency and by remedial action category.

Appendix C presents a detailed list of installations, arranged by agency, reporting the above listed remedial actions.

These remedial actions reflect, in part, normal air pollution control activities of the agencies funded from their regular budgets as well as actions stimulated and accelerated by the promulgation of Executive Order 11282 and the need to prepare the 5-year phased and orderly plan. Congressional action on fiscal year 1969 budget requests had not been completed by April 1, 1968, and therefore, most of these projects represent relatively small expenditures of funds already available to solve relatively simple and inexpensive problems. Abatement actions at large installations or on very expensive projects generally must await funding. Installation of electrostatic precipitators at the large Tennessee Valley Authority powerplants is an exception to this situation, because of alternate sources of funds.

These reports also reflect favorably on the efforts of agencies to comply with the strict sulfur-oxide regulations governing the New York and Chicago standard consolidated areas and the standard Metropolitan Statistical Area of Philadelphia.

Fuels for use in these areas by the civilian agencies are obtained principally by the General Services Administration. Inquiry to the General Services Administration elicited the information that all fuels used in the Chicago standard consolidated area are in conformity with the requirements of the Executive order.

Attempts to secure bids on fuels which would meet the Executive order regulations for New York and Philadelphia failed for the most part. The limited response required a 64 percent premium over costs of existing fuel. Readvertising for a maximum of 1 percent sulfur content brought good response resulting in an 11 percent to 16 percent increase in costs over previous higher sulfur fuels. These responses were considered acceptable. This means that, for these areas, a No. 4 fuel oil with 0.7 percent sulfur and a No. 6 fuel oil with 1.0 percent sulfur maximum will be used for the 1968-69 heating season.

This success in securing fuel oil with 1 percent or slightly less than 1 percent sulfur is encouraging and forecasts a considerable improvement in future sulfur-oxide emissions; additional improvements will accrue as a result of conversions to natural gas.

V. WASHINGTON, D.C., METROPOLITAN AREA

Considerable progress in controlling air pollution has been made by Federal facilities in the area following the National Capital Metropolitan Area Interstate Air Pollution Abatement Conference held by the Department of Health, Education, and Welfare in December 1967. Open burning has been discontinued at Kenilworth Dump in the District of Columbia and a sanitary landfill has been started. The Department of Health, Education, and Welfare, the Department of the Interior and the government of Washington, D.C. were instrumental in effecting this long-sought change.

The Department of Commerce has completed conversion of the heating plant at the National Bureau of Standards in Gaithersburg, Md., to burn natural gas, with No. 2 fuel oil as standby; and the Treasury Department has modified the classified-waste incinerator at the Bureau of Engraving and Printing in Washington, D.C. Pending funds for replacement, an incinerator at the Agricultural Research Station in Beltsville, Md., has been repaired by the Department of Agriculture.

Conversion of heating plants to burn natural gas is underway at the Goddard Space Flight Center of the National Aeronautics and Space Administration in Greenbelt, Md., and at the National Zoological Park of the Smithsonian Institution in Washington, D.C.

With respect to the Department of Health, Education, and Welfare, the Food and Drug Administration in Beltsville, Md., has reduced particulate emissions from a faulty incinerator by making operational changes; several incinerators have been eliminated on the Howard University campus in Washington, D.C., by transporting refuse to the District of Columbia incinerators; St. Elizabeth's Hospital in the District has contracted for replacement of a faulty pathological incinerator, has installed smoke meters on coal and oil-burning boilers and has secured funds for equipping the main refuse incinerator with air pollution control equipment; the National Institutes of Health in Bethesda, Md., is now using a No. 6 fuel oil with a maximum sulfur content of 0.5 percent, is redesigning classified waste incinerators for installation of both afterburners and water scrubbers, and is engaged in a joint effort with the Department of the Army and the Department of the Navy to design and construct a large general waste incinerator to serve the National Institutes of Health, the Naval Medical Center, and Walter Reed Hospital and Annex. Construction will be at the annex site in Maryland. The Department of the Army has been issued a permit for land use for this project and design has been started.

The General Services Administration, as anticipated, is playing an important role in the Washington, D.C. metropolitan area, as elsewhere, with respect to procurement of low-sulfur fuel. Since November 1967, all fuel oil procured for the Department of Defense facilities in the Washington area by the General Services Administration has contained 2 percent sulfur. For the 1968-69 heating season, fuels have

been secured at 1.5 percent sulfur, which is in accord with the recommendations of the Washington abatement conference. Furthermore, it is expected that for the 1969-70 heating season 1 percent sulfur fuels will be provided. Department of Defense facilities involved are the following:

- Arlington Hall Station, Arlington, Va.;
- Pentagon Building, Arlington, Va.;
- Cameron Station, Alexandria, Va.;
- Fort Belvoir, Springfield, Va.;
- Harry Diamond Laboratories, Washington, D.C.;
- Fort Leslie J. McNair, Washington, D.C.;
- Walter Reed Army Medical Center, Washington, D.C.;
- N. G. Camp Sims, Washington, D.C.;
- Walter Reed Army Medical Center (Forest Glen Annex), Maryland;
- Army Map Service, Montgomery County, Md.;
- Andrews Air Force Base, Maryland;
- Naval Research Laboratory, Washington, D.C.;
- Marine Barracks, Washington, D.C.;
- Naval Communications Station, Cheltenham, Md.;
- Naval Medical Center, Bethesda, Md.; and
- Naval Ordnance Laboratory, White Oaks, Md.

Additional activities of the General Services Administration in this area have resulted in the replacement of three boilers, previously burning number 6 fuel oil, with two gas-fired boilers at the old Bureau of Standards property on Connecticut Avenue in the District of Columbia. The General Services Administration also has reported that all of the major coal-burning steam plants operated by the General Services Administration now are using coal containing 1 percent sulfur or less.

Remaining problems of air pollution abatement in Federal facilities in and around Washington, D.C., generally are minor and work is proceeding on many of these at this time.

VI. MISCELLANEOUS ACTIVITIES

During calendar year 1968, emission inventories of all 77 Federal facilities in the Kansas City area were completed and entered in the record of the second session of the Kansas City, Kans.-Kansas City, Mo. Interstate Air Pollution Abatement Conference. A similar inventory was completed of the 185 Federal facilities in the Philadelphia, Pa., area in conjunction with the Delaware Valley regional air quality program which is being conducted cooperatively by Federal, State, and local agencies.

In view of the mandate for Federal facilities to exhibit leadership in abating air pollution, inventories of emissions from Federal facilities have been completed in Washington, D.C., New York, Chicago, Philadelphia, Chattanooga, and Detroit and started in Denver, St. Louis, Boston, and San Francisco. Eventually, all 32 regions will be completely inventoried. Information will be helpful to the facilities themselves and will be important in any overall area emission studies which must be carried out before control programs are developed by States and communities concerned within each region.

Special studies also are underway concerning air pollution problems and control practices in Federal foundries, ammonia oxidation plants used to manufacture nitric acid, and sulfuric acid manufacturing plants. Information secured from these studies will be helpful in developing improved control techniques for these air pollutants.

The Department of Defense again has included proposals for control of emissions from the Volunteer Army ammunition plant in Hamilton County, Tenn. Proposals for this plant have been included in fiscal year 1969 plans but were not funded by Congress. This plant probably is the worst single Federal source of air pollution, principally oxides of nitrogen, in the United States. It has been the source of complaints, congressional inquiries and general citizen dissatisfaction in its vicinity. Failure to fund the 1969 project was a distinct disappointment and it is hoped that corrective measures will be funded in fiscal year 1970.

Technical assistance on specific problems associated with boiler operations was given to the Department of Defense, Veterans' Administration, and the Department of Health, Education, and Welfare. Similar help concerning incinerators was given to the Smithsonian Institution and to the Departments of Defense, Interior, and Agriculture.

A conference was held with representatives of the Corps of Engineers (civil works) concerning the disposal of debris from New York Harbor. Representatives of the Corps were reminded that the pit incinerator being constructed at Caven Point, N.J., in its proposed form, may be inadequate to meet the standards concerning particulate emissions. If this should prove to be true following testing of this device, further design and engineering will be necessary to secure compliance with the regulations.

A carbon monoxide control study related to automotive traffic was started at selected border stations at the request of the Public Buildings Service of the General Services Administration.

The Washington, D.C., Air Pollution Division and the National Park Service of the Department of the Interior were advised concerning an incinerator designed for the destruction of brush and logs. These agencies are attempting to dispose of this waste in a manner which hopefully will replace the current open burning. Specialized activities have been continued to assure the control of exhaust products from missiles and rockets powered with highly toxic propellants. These activities involved close cooperation and interagency liaison with the Department of Defense, National Aeronautics and Space Administration, Atomic Energy Commission, Armed Services Explosives Safety Board, and the National Academy of Sciences-National Research Council. During the year, not a single rocket motor containing beryllium propellant was fired in the open air of the continental United States.

In the interest of providing further assistance during the year, the Federal Facilities Section distributed several hundred copies of the 892-page publication titled "Air Pollution Engineering Manual" to the Federal agencies. Also distributed for comment and technical criticism was the "Interim Guide to Good Practice for Selecting Incinerators for Federal Facilities."

The Section also participated in a training course at Durham, N.C., for approximately 70 engineers of the Army Materiel Command and in a seminar at the Army Environmental Health Agency, Edgewood Arsenal, Edgewood, Md., with representatives of the Army Surgeon General's Office, the Bureau of the Budget and the Federal Water Pollution Control Administration, to review the operation of the 5-year phased and orderly plan.

VII. CONCLUSION

The Federal departments and agencies again this year evidence excellent cooperation with the Department of Health, Education, and Welfare and the Bureau of the Budget for purposes of preventing and controlling air pollution. The reports of progress highlight both the efforts and the intentions of the agencies. With sufficient funding, there is no reason why air pollution control by Federal agencies should not be successful. Announcement of the establishment of the first 32 air quality control regions by the National Air Pollution Control Administration has given further impetus to this program and has defined more sharply than heretofore areas to which specific attention must be provided both by the Federal Government and by State and local organizations.

Sufficient funding will enable prompt abatement of air pollution from Federal establishments.

(11)

APPENDIX A

FISCAL YEAR 1970 PROJECTS TO BE RECOMMENDED BY THE PRESIDENT 1

Agency	Installation	Proposed action
Department of Agriculture	Agricultural Research Center, Beltsville, Md.	Construct new incinerator for Animal Husbandry Meats Laboratory and a new pathological incinerator for Building 129A, Animal Parasite Station, area 1. Convert Heating Plant 309A, area 3 to gas with No. 2 fuel oil as standby.
Atomic Energy Commission	Feed Materials Production Center, Fernald, Ohio	Install sanitary landfill and 2 special purpose incinerators.
Department of Commerce	Argonne National Laboratory, Argonne, Ill.	Convert heating plant to natural gas.
General Services Administration	U.S. Merchant Marine Academy, Kings Point, N.Y.	Conversion of heating plant to No. 2 fuel oil or to gas with oil standby depending on results of engineering feasibility study now underway.
	Pest Office and Courthouse, East St. Louis, Ill.	Convert boiler to oil or gas.
	AEC Building, Germantown, Md.	Install wet scrubber on incinerator.
	Military Personnel Records Center, Overland, Mo.	Convert boiler from coal to No. 2 fuel oil.
	Post office (Back Bay annex), Boston, Mass.	Convert to oil.
Department of Health, Education, and Welfare	Public Health Service Hospital, Detroit, Mich.	Replace boilers and install 2 incinerators.
Smithsonian Institution	National Zoological Park, Washington, D.C.	Improve control of incinerator by wet scrubber and convert coal steamplant to gas.
Tennessee Valley Authority	Shawnee steamplant, Mcracken County, Ky.	Complete installation of electrostatic precipitators on all 10 units.
	Widows Creek steamplant, Jackson County, Ala.	Upgrading electrostatic precipitators on units 7 and 8 will be continued.
	Gallatin steamplant, Sumner County, Tenn.	Complete installation of electrostatic precipitators.
Veterans' Administration	VA Hospital, Bronx, NY	Replace 3 boilers with 1 boiler and convert 2 boilers to gas and No. 2 fuel oil.
	VA Hospital, Butler, Pa.	Replace 3 boilers with 3 boilers burning gas and No. 2 fuel oil.
	VA Hospital, Pittsburgh, Pa. (GM)	Convert 4 boilers to gas and No. 2 fuel oil.
	VA Hospital, Pittsburgh, Pa. (NP)	Convert 3 boilers to gas and No. 2 fuel oil.
	VA center, Dayton, Ohio	Convert 4 boilers to gas and No. 2 fuel oil.
	VA Hospital, Cincinnati, Ohio (Fort Thomas)	Replace 4 boilers with 2 burning gas and No. 2 fuel oil.
	VA Hospital, Brecksville, Ohio	Replace 1 boiler and convert 2 boilers to gas and No. 2 fuel oil.
Department of Defense	Davis-Monthan Air Force Base, Tucson, Ariz.	Install a 75-ton-per-day scrap metal smelter complete with shredding device, automatic loading and weighing equipment, multicomposition chamber design, high-temperature refractory, an automatic metal reclaiming system, dross removal, and air pollution abatement control equipment.
Air Force	Bradley Air National Guard, Windsor Locks, Conn.	Install smoke density recorder meter on boiler.
	Eglin Air Force Base, Ft. Walton Beach, Fla.	Install incinerator in marketing and redistribution area; modify 5 POL storage tanks to floating roof configuration; install wet scrubber for asphalt plant; install catalytic combustion chamber and ducts over gas vents of each of 3 Imhoff tanks.
	Scott Air Force Base, Belleville, Ill.	Install submerged fill-pipe in 7 underground aviation gas tanks.
	Andrews Air Force Base, Camp Springs, Md.	Enlarge Building 3409 (Navy plant) to contain oil-fired equipment and eliminate Building 3743. Convert from coal to low-sulfur fuel oil (No. 2) all boilers in Buildings 3032, 3212, 3755, and 4331. Install smoke density meters to all existing boilers over 10 million BTU input capacity.
	McGuire Air Force Base, Burlington County, N.J.	Convert boilers in Buildings 21-01, 34-02, to natural gas; Buildings 16-23, 18-07, 24-01, 33-22, 34-59, and 19-06 to No. 2 fuel oil. Same for Building 18-01.

McGuire Air Force Base ANG areas, Wrightstown, N.J.	Convert 2 oil burners from No. 4 fuel oil to No. 2 fuel oil.
Lockport Air Force Station, Lockport, N.Y.	Design mechanical filters for boilerhouse stack at main boiler plant.
Wright-Patterson Air Force Base, Greene County, Ohio.	Design gas scrubber for incinerator in building 202.
Brooks Air Force Base, San Antonio, Tex.	Design refuse incinerator to eliminate sanitary landfill operation because of limited land.
Carswell Air Force Base, Fort Worth, Tex.	Repair existing incinerator in building 1730. Base refuse to be disposed of by contract in fiscal year 1970.
McChord Air Force Base, Tacoma, Wash.	Construct incinerator to eliminate burn and cover garbage refuse.
General Mitchell ANG Base, Milwaukee, Wis.	Install smoke density recording meter.
Volunteer Army Ammunition Plant, Hamilton County, Tenn.	For TNT production area, complete installation of instrumentation for TNT waste acid fume recovery system; install additional bubble-cap towers to increase absorption capacity of TNT waste acid recoveries; investigate more efficient air jet to decrease volume of fumes from bi-oil at bi-house to permit introduction of fumes into fume recovery line; make absorption study to determine optimum TNT waste acid recovery conditions; install scrubbers to remove nitrogen oxides from recovery bubble-cap absorption column stack gas and from wash house gases; improve performance of fume lines between mono and bi-houses and acid recovery buildings. For east acid production area, the use of natural gas is awaiting a gas contract; testing to be done to determine feasibility of a mist filter to replace electrostatic precipitators and the Mahon fog filters; possible installation of a combustion unit for nitric acid concentration and scale tanks; for Ammonia Oxidation Plant, improve process control and consider use of catalytic combustion units to eliminate oxides of nitrogen. For the Red Water Incineration Plant use of natural gas is awaiting contract; install an improved feed system and a wet scrubbing system. Problem of eliminating open burning area is under study. Recommendations also have been submitted for a completely modern TNT plant with allied acid facilities to reduce pollution costs.
Joliet Army Ammunition Plant, Joliet, Ill.	Replacement of open burning by a sanitary landfill; install mist eliminator equipment for sulfuric acid concentrators and convert to natural gas; design catalytic combustion units for ammonia oxidation plant; install mist eliminator equipment for oleum production units and for effluents producing units; install fume scrubbing system for TNT recovery buildings and for tetrahydrofuran recovery building; convert to natural gas and install particulate collectors for red water incinerators; use lower sulfur oil for central heating plants and install sanitary landfill for nonexplosive material to eliminate open burning at the load assembly stack unit.
Fort Benjamin Harrison, Indianapolis, Ind.	Design conversion of central coal-fired heating plant to natural gas; design to connect that plant to heating plant No. 2 with steam line; design conversion to No. 2 fuel oil for 2 consolidated messhalls.
U.S. Army Reserve Center, Indianapolis, Ind.	Convert coal-fired heating system to natural gas.
Picatinny Arsenal, Dover, N.J.	Conversion of coal-fired boilers to natural gas with low-sulfur fuel oil standby; use of low-sulfur fuel oil at oil-fired heating plants.
Granite City Army Depot, Granite City, Ill.	Construct incinerator to eliminate 2 open burning areas.
Fort Sam Houston, San Antonio, Tex.	Install system to reclaim used oil thereby eliminating open burning from salvage oil pit.
Aberdeen Proving Ground, Aberdeen, Md.	Install submerged inlets on gasoline storage tanks to reduce loss of gasoline through evaporation.
Edgewood Arsenal, Edgewood, Md.	Design of new incinerator for waste disposal.
Fort George Meade, Odenton, Md.	Design conversion of coal-fired heating plants to either oil- or gas-fired units depending upon economics study.
Valley Forge General Hospital, Phoenixville, Pa.	Replace short stacks on 6 boilers with breeching to existing 100-foot brick stacks and install fly ash collection hoppers; install photoelectric smoke detectors on boilers over 10 M B.t.u. per hour input; design replacement incinerator for a larger facility with smoke and particulate abatement equipment.

APPENDIX A—Continued
FISCAL YEAR 1970 PROJECTS TO BE RECOMMENDED BY THE PRESIDENT 1

Agency	Installation	Proposed action
Department of Defense—Continued Army—Continued	Frankford Arsenal, Philadelphia, Pa.----- Fort Dix, Burlington, N.J.-----	Design for conversion from No. 6 oil to combination of No. 2 oil and gas. Construct steamline to an oil-fired plant in reception center and then remove coal-fired boiler in building 3684.
	Fort Hancock, Highlands, N.J.-----	Change fuel from coal to gas with oil standby at central heating plant.
	Arlington Hall Station, Arlington, Va.-----	Renovate and rebuild incinerators.
	Fort Belvoir, Fairfax County, Va.-----	Fuel conversion to natural gas with low-sulfur fuel oil as standby for 2 boilers using coal (10-100 M B.T.U. per hour).
	Fort McNair, Washington, D.C.-----	Replace underground gasoline storage tank and include submerged type fill pipe to prevent gasoline loss.
	Michigan missile plant, Warren, Mich.----- Naval Air Station, Alameda, Calif.-----	Conversion of 2 boilers to gas fuel from coal. Provide pressure breather valves for aviation gas storage tanks 97A to 97E; set control at 2.5 p.s.i. Phase out tanks 342A and 342B, fiscal year 1972 or sooner.
	Marine Corps Supply Center, Barstow, Calif.----- Naval Weapons Station, Concord, Calif.----- San Francisco Bay Naval Shipyard, Hunters Point, San Francisco, Calif.-----	Install on-station sanitary landfill to replace open-pit burning. Provide multichamber incinerator with afterburner or install a wet pulping system. Provide 2 direct flame afterburners for bake ovens in building 211 and building 271. Design and engineering studies to replace a dry pulp paper disintegrator with a wet pulping system.
	San Francisco Bay Naval Shipyard, Mare Island, Vallejo, Calif.-----	Improve ventilation of building 53. Increase frequency of cleanout of oil scrubber and replace filter pads in the scrubber more frequently. These changes are directed at odor control from rubber milling operations.
	Fleet Training Center, Naval Station, San Diego, Calif.----- Naval Fuel Depot, San Pedro, Calif.-----	Construct air pollution control system to eliminate smoke from this activity. Installation of a vapor collection and flare system to collect and burn vapors during filling operations for a truck loading facility and four fuel storage tanks.
	Naval Station, Treasure Island, San Francisco, Calif.-----	Engineering study to provide baghouse filter on cyclone exhaust from a classified paper disintegrator at building 445.
Navy	Marine Corps Air Station, Kaneohe Bay, Honolulu, Hawaii.-----	Install sanitary landfill to replace open burning dump.
	Fleet Training Group, Pearl Harbor, Honolulu, Hawaii.----- Naval Ordnance Station, Forest Park, Ill.----- Naval Training Center, Great Lakes, Ill.----- Naval Air Station, Olathe, Kans.----- Naval Shipyard, Boston, Mass.----- Naval Communications Station, Cheltenham, Md.----- Naval Ship Research and Development Center, Carderock, Md.----- Naval Ammunition Depot, Earle, N.J.-----	Design smoke abatement facility for firefighting training school. Design new incinerator with air pollution control equipment. Install afterburner system to eliminate smoke from the firefighting training school. Design smoke control system for firefighting training operation. Design high-efficiency collector to control particulates from powerplant. Install wet scrubber to control emissions from refuse incinerator. Install smoke detectors on heating plant in building 6.
	Naval Air Station, Brooklyn, N.Y.-----	Convert from No. 4 residual fuel oil to No. 2 distillate oil; eliminate open burning and dispose of lumber by a chipper.
	Naval Hospital, St. Albans, N.Y.-----	Convert from No. 6 and No. 4 residual fuel oil to No. 2 distillate in building No. 6 and building No. 4, respectively.
	Naval Supply Center, Craney Island, Norfolk, Va.-----	Convert from No. 6 residual fuel oil to No. 2 distillate oil in building 64.
	Naval Damage Control Training Center, Philadelphia, Pa.-----	Installation of smoke detectors and alarms on boilers; provide waste oil destruction to replace waste oil pit; construct new incinerator or burn in city incinerator. Construct smoke elimination system for this fire center.

Corps of Engineers (civil functions).....	Potomac and Anacostia Rivers, Washington, D.C.....	Install incinerator to dispose of drift and debris collected from these rivers. May be open-pit type or mounted on a barge. Decision rests upon prototype open-pit device operation at Caven Point, N.J.
	Baltimore Harbor, Baltimore, Md. (drift removal)	Install overfire air pit incinerator at Fort McHenry.
	Puget Sound and tributary waters, Washington, D.C.	Continue interim landfill operation and conduct engineering study to determine best solution.
	Dipper dredge "Kewaunee," Lake Michigan.....	Install smoke detector, alarm, or recorder on vessel.

¹ Tentative listing supplied by the Bureau of the Budget, Dec. 27, 1968.

APPENDIX B
SUMMARY OF REMEDIAL ACTIONS BY FEDERAL DEPARTMENTS OR AGENCIES, FISCAL YEAR 1968

Department or agency	Progress reports	Remedial actions	Stopped burning or poor incineration	New or upgraded incinerators	Replacement of heating plants	Existing heating plants improved	New or improved particulate collectors	Smoke or other monitor systems installed	Using lower sulfur content coal or fuel oil	Converted heating plant from coal or oil to gas	Converted to electricity	Reduced chemical or vapor emissions	Other ¹
Grand total	387	442	126	9	14	7	8	16	103	37	1	31	90
Defense:													
Army	88	115	25	3	1	1	3	4	56	3		7	12
Navy	67	94	7		2			8	22	3		15	36
Air Force	39	43	13	2	1	3	2	1	5	2		6	8
Supply Agency	1		1										
Corps of Engineers	2	5											
Atomic Energy Commission	15	20	3	1		1	1	3	1			2	3
Commerce	3	4											
General Services	13	14							2	1			1
Health, Education, Welfare	11	11	1	2		2			7	8			4
Interior	11	12	2			4			4	1			1
Justice	20	2							1	2			4
National Aeronautics and Space	3	2											1
Post Office	69	69	68							1			3
Smithsonian Institution	1	7											1
Tennessee Valley Authority	6	4	2				2				1	1	3
Transportation	4	4							2				1
Veterans Administration	34	36	3	1	10					17			5

¹ "Other action" includes studies, designs, and project cost estimates completed or underway. It also includes contracts awarded or advertised for bid.

APPENDIX C ANNUAL REPORT OF PROGRESS BY INSTALLATION DURING FISCAL YEAR 1968

Agency	Installation	Actions
Department of Defense: Defense Supply Agency Army	Defense Supply Support Center, Philadelphia, Pa.	Conversion of steam boiler to gas-oil firing completed February 1968.
	Fort McClellan, Anniston, Ala.	Open burning discontinued during fiscal year 1968.
	Redstone Arsenal, Huntsville, Ala.	Installed vapor emission control devices in nine tanks during fiscal year 1968.
	Fort Rucker, Daleville, Ala.	10 coal-fired boilers replaced or converted to oil or gas during fiscal year 1968.
	Fort Richardson, Anchorage, Alaska.	28 furnaces converted to oil or gas.
	Fort Wainwright, Fairbanks, Alaska.	Construction contract awarded January 1968. Completion scheduled for October 1968.
	Yuma Proving Grounds, Yuma, Ariz.	Open burning discontinued and sanitary landfill established in fiscal year 1968.
	Fort Chaffee, Fort Smith, Ark.	Vapor emission controls installed on all gasoline storage tanks during fiscal year 1968.
	Pine Bluff Arsenal, Pine Bluff, Ark.	Open burning discontinued and sanitary landfill established during fiscal year 1968.
		Open burning and white phosphorus slag eliminated (Shipping tag to TVA). Renovating incinerator—contract awarded February 1968. Operation scheduled for fiscal year 1969.
		Design study for criteria and cost estimate completed December 1967. Preliminary survey chlorine manufacture facility made in July 1967.
	Hunter Liggett Military Reservation, Jolon, Calif.	Sanitary landfill for refuse disposal established during fiscal year 1968.
	Fitzsimmons General Hospital, Aurora, Colo.	Discontinued use of one incinerator during fiscal year 1968.
	Rocky Mountain Arsenal, Denver, Colo.	3 monitoring stations installed March 1968. Submerged inlets on 2 storage tanks, fiscal year 1968.
	Fort Leslie J. McNair, Washington, D.C.	Residual fuel oil with a maximum sulfur content of 2 percent has been used since July 1, 1967.
	Walter Reed Army Medical Center (Main), Washington, D.C.	Do.
	Atlanta Army Depot, Forest Park, Ga.	Submerged inlets installed on all underground tanks during fiscal year 1968.
	Fort Gordon, Augusta, Ga.	255 coal-fired furnaces removed from construction area. 4 gasoline tanks removed during fiscal year 1968.
	Fort McPherson, Atlanta, Ga.	Open burning discontinued. Waste disposed off post.
	Chicago USAR Center No. 1 (Moskale), Chicago, Ill.	Fuel oil containing maximum of 1 percent sulfur has been used since Dec. 1, 1967.
	Chicago USAR Center No. 2 (Gibson), Chicago, Ill.	Do.
	Chicago USAR Center No. 3 (Lincolnwood), Chicago, Ill.	Do.
	(West Germak Rd.).	Do.
	Chicago USAR Center No. 3 (Lincolnwood), Chicago, Ill.	Do.
	(North Kedzie Ave.).	Do.
	Chicago USAR Center, Chicago, Ill. (South Cornell St.).	Do.
	Chicago USAR Center, Chicago, Ill. (South Exchange Ave.).	Do.
	Joliet Army Ammunition Plant, Joliet, Ill.	Preliminary engineering studies made on control of emissions from manufacturing processes. Negotiating design contract for upgrading coal-fired heating plants. Soliciting lower sulfur coal and oil.
	Missile site C-80, Arlington Heights, Ill.	Fuel oil containing maximum of 1 percent sulfur has been used since Dec. 1, 1967.
	Rock Island Arsenal, Rock Island, Ill.	Installed 3/4 of the abatement devices planned for metal plating shop in fiscal year 1968.
	Fort Sheridan, Highland Park, Ill.	Fuel oil containing maximum of 1 percent sulfur has been used since Dec. 1, 1967. Construction contract awarded January 1968 to convert heating plant from coal to gas. Completion date November 1968.

APPENDIX C—Continued
ANNUAL REPORT OF PROGRESS BY INSTALLATION DURING FISCAL YEAR 1968—Continued

Agency	Installation	Actions
Department of Defense—Continued Army—Continued	Waukegan USAR Center, Waukegan, Ill.	Fuel oil containing maximum of 1 percent sulfur has been used since Dec. 1, 1967.
	Camp Aterbury, Edinburg, Ind.	Open burning of uncontaminated waste discontinued and landfill established fiscal year 1968.
	Sunflower Army Ammunition Plant, Lawrence, Kans.	Open burning of uncontaminated waste discontinued and landfill established fiscal year 1968. Awarded design contract Apr. 30, 1968 to convert steam plant from coal to natural gas and No. 2 fuel oil standby.
	Fort Knox, Louisville (Hardin, Meade, Bullitt Counties) Ky.	Open burning discontinued in fiscal year 1968.
	Army Map Service, Brookmont, Md.	Residual fuel oil containing maximum of 2 percent sulfur used since July 1, 1967.
	Fort George G. Meade, Odenton, Md.	Smoke detectors and recorders installed on 10 boilers during fiscal year 1968.
	Walter Reed Army Medical Center Annex, Forest Glen, Md.	Residual fuel oil containing maximum of 2 percent sulfur has been used since July 1, 1967.
	Boston Army Base, Boston, Mass.	Smoke detectors installed on 6 boilers in the Central Boiler Plant September 1967.
	Fort Devens, Ayer, Mass.	Incinerators have been inactivated during fiscal year 1968.
	Fort Leonard Wood, Waynesville, Mo.	Contract awarded to convert 8 coal-fired boilers and 181 coal-fired heating systems to oil-fired before 1968-69 heating season.
	Fort Missoula, Missoula, Mont.	Eight coal-fired boilers changed to gas in fiscal year 1968.
	Bayonne military ocean terminal, Bayonne, N.J.	Fuel oil procured for use after May 1, 1968, will meet New Jersey State limit for sulfur content.
	Burlington Army ammunition plant, Burlington, N.J.	Fuel oil procured after May 1, 1968, will meet New Jersey State sulfur limit.
	Camden USAR Center, Camden, N.J.	Fuel oil containing maximum sulfur content of 1 percent in use since Nov. 1, 1967. Oil procured after May 1, 1968, will meet New Jersey State sulfur limit.
	Fort Dix, Wrightstown, N.J.	Fuel oil containing 1 percent sulfur in use since Nov. 1, 1967. Procuring anthracite with 0.9 percent sulfur content for use in fiscal year 1969. Bituminous coal for use in fiscal year 1969 to contain 1 percent maximum sulfur. Fuel oil procured after May 1, 1968, will meet New Jersey State sulfur limit.
	Fort Hancock, Highlands, N.J.	Fuel oil used since Nov. 1, 1967, contains 1 percent maximum sulfur content. Procuring bituminous coal with maximum sulfur content of 1 percent for fiscal year 1969. Fuel oil procured after May 1, 1968, will meet New Jersey State sulfur limit.
	Kearny USAR Center, Kearny, N.J.	Fuel oil used since Nov. 1, 1967, contains 1 percent sulfur maximum. Fuel oil procured after May 1, 1968, will meet New Jersey State sulfur limit.
	Camp Klimer, Edison, N.J.	Fuel oil used since Nov. 1, 1967, contains 1 percent sulfur maximum. Fuel oil procured after May 1, 1968, will meet New Jersey State sulfur limit.
	Alexander Hamilton USAR Center, Lodi, N.J.	Fuel oil used since Nov. 1, 1967, contains 1 percent sulfur maximum. Fuel oil procured after May 1, 1968, will meet New Jersey State sulfur limit.
	Fort Monmouth, Easton, N.J.	All open burning discontinued as of May 22, 1967, and refuse buried in landfill. Fuel oil used since Nov. 1, 1967, contains 1 percent sulfur and oil procured after May 1, 1968, will meet New Jersey State sulfur limits. Coal procured for use in fiscal year 1969 will contain 1 percent sulfur. Bituminous coal and 0.9 percent in anthracite.
	Fort Monmouth Subpost, Charles Wood Area, N.J.	Fuel oil used since Nov. 1, 1967, contains 1 percent sulfur and oil procured after May 1, 1968, will meet New Jersey State sulfur limits. Coal procured for use in fiscal year 1969 will contain 1 percent sulfur. Bituminous coal and 0.9 percent in anthracite.
	Sgt. J. J. Sadowski USAR Center, Newark, N.J.	Fuel oil used since Nov. 1, 1967, contains 1 percent sulfur and oil procured after May 1, 1968, will meet New Jersey State sulfur limits.

Nixon USAR Center, Nixon, N.J.-----
 Picatinny Arsenal, Dover, N.J.-----
 Fuel oil procured after May 1, 1968, will meet New Jersey State sulfur limits. Discontinued open burning and use of incinerator. Landfill established. Fuel oil used since Nov. 1, 1967, contains 1 percent sulfur, and oil procured for use after May 1, 1968, will meet New Jersey State sulfur limits. Bituminous coal for use in fiscal year 1969 being procured with maximum sulfur content of 1 percent. Design contract being negotiated for fuel conversion to gas.

Philadelphia Air Defense Site, Pedricktown, N.J.-----
 Fuel oil used since Nov. 1, 1967, contains 1 percent sulfur, and oil procured after May 1, 1968, will meet New Jersey State sulfur limits.

Trenton USAR Center, Trenton, N.J.-----
 Fort Wingate Army Depot, Gallup, N. Mex.-----
 Open burning replaced by landfill in March 1967. Construction contract awarded Apr. 30, 1968, to convert coal-fired boilers to gas.

Army Pictorial Center, New York City (Long Island City), N.Y.-----
 Fuel oil used since Nov. 1, 1967, contains 1 percent sulfur maximum.

Brooklyn military ocean terminal, New York (Kings County), N.Y.-----
 Fuel oil used after May 31, 1969, will contain 1 percent sulfur maximum.

Fort Hamilton, Brooklyn, N.Y.-----
 Smoke recorders installed on 3 boilers. Fuel oil used since Nov. 1, 1967, contains 1 percent sulfur maximum. Design contract being negotiated for upgrading incinerators.

Brig. Gen. T. Roosevelt, Jr. USAR Center, Hempstead, N.Y.-----
 Fuel oil used since Nov. 1, 1967, contains 1 percent sulfur maximum.

Miller Army Airfield, Staten Island, N.Y.-----
 Do.-----
 Sgt. Joseph E. Muller USAR Center, New York City (East 238th St.), N.Y.-----
 Do.-----
 S. Sgt. V. Q. Kelly USAR Center, New York City (West 42d St.), N.Y.-----
 Do.-----
 2d Lt. Thomas J. McDonald USAR Center, New York City (Goethals Ave., Jamaica), N.Y.-----
 Do.-----

Seneca Army Depot, Romulus, N.Y.-----
 Changed from coal firing to oil burners on 3 boilers (Building 319) during fiscal year 1968. Fuel oil used since Nov. 1, 1967, contains 1 percent sulfur maximum.

Fort Tilden USAR Center, New York City, N.Y.-----
 Inactive status since July 31, 1967.

Fort Totten, New York City, N.Y.-----
 Fuel oil used since Nov. 1, 1967, contains 1 percent sulfur maximum.

USA Directorate General Support Maintenance Activity, Belmore, N.Y.-----
 Do.-----

Fort Wadsworth, New York City, N.Y.-----
 Open burning discontinued during fiscal year 1968. Wastes removed by contract.

Watervliet Arsenal, Watervliet, N.Y.-----
 Open burning discontinued during fiscal year 1968.

Fort Bragg, Fayetteville, N.C.-----
 Open burning discontinued and landfill established as of May 1, 1968. Incinerator plans canceled.

Umatilla Army Depot, Hermiston, Oreg.-----
 Fuel oil used since Nov. 1, 1967, contains 1 percent sulfur maximum.

Frankford Arsenal, Philadelphia, Pa.-----
 Anthracite containing 0.9 percent sulfur being procured for use in fiscal year 1969.

Norristown USAR Center, Norristown, Pa.-----
 Fuel oil used since Nov. 1, 1967, contains 1 percent sulfur maximum.

Valley Forge General Hospital, Phoenixville, Pa.-----
 Do.-----

Horsham USAR Center, Willow Grove, Pa.-----
 Do.-----

Camp Bullis, San Antonio, Tex.-----
 Open burning discontinued on July 1, 1967, and sanitary landfill established.

Fort Hood, Bell and Coryell Counties, Tex.-----
 Do.-----

Fort Sam Houston, San Antonio, Tex.-----
 Do.-----

Red River Army Depot, Texarkana (Bowie County), Tex.-----
 Rubber previously burned is now stockpiled for future sale. Submerged inlets installed on 2 tanks during fiscal year 1968.

Camp Stanley, San Antonio, Tex.-----
 Open burning discontinued on July 1, 1967, and sanitary landfill established.

Fort Wolters, Mineral Wells, Tex.-----
 1 paper pulper installed March 1968.

Arlington Hall Station, Arlington, Va.-----
 Residual fuel oil used since July 1, 1967, contains 2-percent sulfur maximum.

Fort Belvoir, Mount Vernon, Va.-----
 Do.-----

Cameron Station, Alexandria, Va.-----
 Do.-----

Fort Lee, Fort Lee, Va.-----
 2 fuel conversions (coal to oil) were accomplished. Design completed for proposed conversion to gas with oil standby.

APPENDIX C—Continued
ANNUAL REPORT OF PROGRESS BY INSTALLATION DURING FISCAL YEAR 1968—Continued

Agency	Installation	Actions
Department of Defense—Continued Army—Continued	Fort Myer, Arlington, Va.----- Vint Hill Farms Station, Warrenton, Va.----- Fort Lewis, Tacoma, Wash.----- Yakima Firing Center, Yakima, Wash.----- Holston Army ammunition plant, Sullivan and Hawkins Counties, Tenn.----- Volunteer Army ammunition plant, Chattanooga, Tenn.-----	Residual fuel oil used since July 1, 1967, contains 2-percent sulfur maximum. Replaced the 3 classified waste incinerators with 1 Smoketrol unit and 6 gas afterburners. 250 wornout coal-fired furnaces replaced with oil-fired units in fiscal year 1968. Open burning discontinued and sanitary landfill established in fiscal year 1968. Engineering study, 90 percent complete, for control of particulates from 13 boilers in coal-fired heating plants. Pending modernization of this old plant, a variety of emission reduction devices are being installed, requested, or studied.
Corps of Engineers	New York Harbor drift removal project, New York district office, New York, N.Y.----- Derrick boat "Tonawanda," Cleveland, Ohio (home port)-----	Design complete contract let and construction complete for developing the area; 3 contracts let for long-lead construction (fans, motors, hoists, transformers); contract for general construction of incinerator proper now out for bids. New burners installed permitting use of No. 2 distillate fuel in lieu of No. 5 previously used.
Navy	Naval Air Station, Alameda, Alameda, Calif.----- Naval Weapons Station, Concord, Concord, Calif.----- Naval Air Station, Lemoore, Lemoore, Calif.----- Naval Station Long Beach, Long Beach, Calif.----- Naval Air Station, Moffett Field, Sunnyvale, Calif.----- Naval Postgraduate School, Monterey, Monterey, Calif.----- Naval Hospital, Oakland, Oakland, Calif.----- Naval Supply Center, Oakland, Oakland, Calif.----- Naval Facility, Point Sur, Big Sur, Calif.----- Fleet Training Center, Naval Station, San Diego, Calif.----- San Francisco Bay Naval Shipyard, Hunter Point Site, San Francisco, Calif.----- San Francisco Bay Naval Shipyard, Mare Island Site, Vallejo, Calif.----- Naval Communication Station, Stockton, Calif.----- Naval Station, Treasure Island, San Francisco, Calif.-----	Submerged inlets for motor gasoline storage tanks. June 30, 1968, expected completion date. Submerged inlets for motor gasoline storage tank. June 30, 1968, expected completion date. Open burning discontinued and on-station sanitary landfill established May 1967. Submerged inlets for motor gasoline tanks completed January 1968. Paper pulper installed November 1967. Incineration of garbage discontinued. Hauled away by contract. Submerged inlets on motor gasoline storage tanks by June 1968. Open burning discontinued. Now using off-station landfill. Submerged inlets on motor gasoline storage tanks in June 1968. Submerged inlets on motor gasoline storage tanks to be completed by June 30, 1968. Firebrick and grate completed March 1968. Submerged inlets on motor gasoline storage tanks to be completed by June 30, 1968. Submerged inlets on motor gasoline storage tanks to be completed by June 30, 1968. Contract for preparation of 30 percent final plans and specifications will be let before June 30, 1968. Architect-engineer selected. Boiler plants in buildings 521 and 203 converted to interruptible natural gas in May and October 1967. Submerged inlets on motor gasoline storage tanks to be completed by June 30, 1968. Powerplant, building 121 converted to natural gas, June 25, 1967. Submerged inlets on motor gasoline tanks to be completed by June 30, 1968. Submerged inlets on motor gasoline storage tanks to be completed June 30, 1968. Smoke elimination facility contract awarded Jan. 19, 1968. Boiler contract awarded in April 1968. Submerged inlets on motor gasoline tanks to be completed by June 30, 1968.
	Naval Research Laboratory, Washington, D.C.----- Naval Air Station, Key West, Key West, Fla.----- Naval Station, Key West, Key West, Fla.-----	Smoke detectors ordered for installation in summer of 1968. In-house study of refuse disposal practice completed. In-house study of refuse disposal in Key West area completed. (Central incinerator for all area naval activities recommended.)

Marine Corps Supply Center, Albany, Albany, Ga.----- Engineering study complete. (Recommends sanitary landfill to replace 2 open-burning dumps.)

Naval Air Station, Barber's Point, Barber's Point, Hawaii----- Final plans and specifications being prepared for sanitary landfill.

Naval Ordnance Station, Forest Park, Ill.----- Do.

Naval Air Station, Glenview, Ill.----- Fuel procured since Nov. 1, 1967, has contained a maximum of 1 percent sulfur.

Navy Public Works Center, Great Lakes, Great Lakes, Ill.----- Contract awarded for firm gas for the main powerplant effective Nov. 1, 1968, for 95 percent of annual fuel. Contract awarded for design of control devices for main powerplant. Fuel used since Nov. 1, 1967, has had a limit of 1 percent sulfur.

Naval Training Center, Great Lakes, Great Lakes, Ill.----- Project cost estimate completed for firefighting school smoke elimination facility.

Public Works Center, Guam, Orote Point, Guam.----- Plans completed for a sanitary landfill.

U.S. Naval Academy, Annapolis, Md.----- New heating plant under construction. Estimated completion date, November 1968.

Naval Research Laboratory, Chesapeake Beach, Md.----- Smoke de editors ordered.

Naval Ordnance Laboratory, Silver Spring, Md.----- Project cost estimate completed Aug. 15, 1967, for boiler smoke control and refuse disposal.

Naval Shipyard, Boston, Boston, Mass.----- Design project underway (to control incinerator smoke).

Naval Auxiliary Air Station, Fallon, Nev.----- Project cost estimate completed Aug. 15, 1967, for boiler smoke control and refuse disposal.

Open-burning discontinued; contract refuse hauling to on-station landfill operated by Seabees. Submerged inlets on motor gasoline storage tanks to be completed by June 30, 1968.

Naval Ammunition Depot, Hawthorne, Hawthorne, Nev.----- Submerged inlets on motor gasoline storage tanks to be completed June 30, 1968.

Goldsbrough Housing (part of Supply Center) Bayonne, N.J.----- Design completed fiscal year 1968. Disestablishment anticipated June 30, 1968. Installation will be under Army.

Reserve Training Center, Clifton, N.J.----- Fuel procured since Nov. 1, 1967, has contained 1 percent sulfur maximum.

Ammunition Depot, Earle, N.J.----- Do.

Reserve Training Center, Elizabeth, N.J.----- Do.

Reserve Training Center, Jersey City, N.J.----- Do.

IND Reserve Shipyard, Newark, N.J.----- Do.

Reserve Training Center, Freeport, N.J.----- Do.

Headquarters, 1st Marine Corps District, Garden City, N.Y.----- Do.

Mitchel Manor, Federal Housing Annex of Naval Station, Brooklyn, Garden City, N.Y.----- Do.

Reserve Training Center, Huntington, N.Y.----- Do.

Naval and Marine Corps Reserve Training Center, Fort Schuyler, N.Y., Bronx, New York.----- Do.

Shipyard (Naval Station, Brooklyn) Brooklyn, Kings County, N.Y.----- Design authorized for special project AI-68 (incinerator scrubbers).

Marine Corps Reserve Training Center, New York City, N.Y.----- Fuel procured since Nov. 1, 1967, has contained 1 percent sulfur maximum.

Naval Air Station, New York, Brooklyn, N.Y.----- Fuel procured since Nov. 1, 1967, has contained 1 percent sulfur maximum. Plans and specifications completed for boiler replacement building 4-B. Project cost estimate completed for fuel conversion of 3 boilers in fiscal year 1968. MCON project will include branch gas piping to tenant activity.

Hospital, St. Albans, St. Albans, Queens County, N.Y.----- Fuel used since Nov. 1, 1967, has contained 1 percent sulfur maximum. Special project with certificate of urgency approved by EASTDIV for scrubber and modifications in fiscal year 1968. Project cost estimate completed for boiler conversion in fiscal year 1968.

Reserve Training Facility, Youngstown, N.Y.----- Spectil project completed in fiscal year 1968, EASTDIV approval anticipated in May 1968.

Naval Air Development Center, Johnsville, Pa.----- Fuel procured since Nov. 1, 1967, has contained 1 percent sulfur maximum. Negotiations underway for selecting A. & E. firm to prepare project cost estimate (smoke control).

APPENDIX C—Continued
ANNUAL REPORT OF PROGRESS BY INSTALLATION DURING FISCAL YEAR 1968—Continued

Agency	Installation	Actions
Department of Defense—Continued Navy—Continued	Naval Supply Depot, Mechanicsburg, Pa.....	Fuel procured since Nov. 1, 1967, has contained 1 percent sulfur maximum. Fuel selection survey completed and awaiting preparation of project for funding.
	U.S. Marine Corps Supply Activity, Philadelphia, Pa.....	Fuel selection survey submitted to Marine Corps Supply Activity which has obtained 1 percent sulfur fuel oil since Nov. 1, 1967.
	Naval Air Engineering Center, Philadelphia, Pa.....	Fuel selection survey completed and awaiting funding. Fuel procured since Nov. 1, 1967, has contained 1 percent sulfur maximum.
	Naval Damage Control Center, Philadelphia, Pa.....	Engineering investigation underway to determine most feasible method of eliminating firefighting school.
	U.S. Naval Hospital, Philadelphia, Pa.....	Fuel procured since Nov. 1, 1967, has contained 1 percent sulfur maximum. Negotiation underway for selection of A. & E. firm to prepare project cost estimate.
	Naval Shipyard, Philadelphia, Pa.....	Fuel procured since Nov. 1, 1967, has contained 1 percent sulfur maximum. Negotiations underway for selection of A. & E. firm to prepare project cost estimate for control of fly ash and smoke.
	Naval Supply Depot, Philadelphia, Pa.....	Fuel procured since Nov. 1, 1967, has contained 1 percent sulfur maximum. Authorized to start plans and specifications for heating plant fuel conversion.
	Naval Air Station, Willow Grove, Willow Grove, Pa.....	Fuel procured since Nov. 1, 1967, has contained 1 percent sulfur maximum. Project for new boilers using low sulfur fuel approved.
	U.S. Naval Station, Roosevelt Roads, Celba, Humaco, P.R.....	Construction underway to install emission control valves and filters in exhaust fans, June 1968 expected completion date.
	U.S. Marine Corps, Camp Garcia detachment, Isabel II-Vieques, P.R.....	Sanitary landfill implemented.
	Fleet Training Center, Newport, Newport, R.I.....	Project cost estimate completed Aug. 4, 1967 (smoke control at fire fighting school).
	Public Works Center, Newport, Newport, R.I.....	Project cost estimate for incinerator completed Aug. 13, 1967. Project cost estimate for fly ash collectors completed June 2, 1967.
	Naval Shipyard, Charleston, Charleston, S.C.....	Open burning discontinued and refuse disposed in sanitary landfill. A. & E. working on program cost estimate for dust collector.
	Naval Supply Center, Craney Island, Norfolk, Va.....	Installation of smoke recorders and alarms on heating plant to be completed by June 1968. A. & E. study underway regarding waste oil disposal problem. Exploring refuse disposal by contract.
Air Force	Naval Public Works Center, Norfolk, Va.....	Preliminary design complete for particulate control devices for waste heat plant. Smoke detectors being designed for buildings P-1 and SU-1.
	Naval Supply Center, Norfolk, Va.....	Completed installation of vacuum pressure relief valve on fuel tank September 1967.
	Naval Air Station, Oceana, Virginia Beach, Va.....	Smoke detectors for housing area heating plant to be installed before June 30, 1968.
	Naval Ammunition Depot, St. Juliens Creek, Portsmouth, Va.....	Smoke detectors, recorders, and alarms have been installed.
	Naval Hospital, Portsmouth, Va.....	Smoke detectors and alarms installed in April 1968.
	Norfolk Naval Shipyard, Portsmouth, Va.....	Smoke detectors installed at Stanley Courts and building 174 heating plant.
	Perrin Air Force Base, Sherman, Tex.....	Open burning eliminated with landfill. When available land is exhausted, then refuse hauling contract will be proposed.
	Lackland Air Force Base, San Antonio, Tex.....	Have requested shredder-pulper to replace classified paper incinerator.
	Elmendorf Air Force Base, Anchorage, Alaska.....	Contracted January 1968 to convert from use of coal to natural gas. Expect completion by October 1968.

Williams Air Force Base, Chandler, Ariz.-----Improvements in auto maintenance shop scheduled for fiscal year 1969. Submerged inlets on 3 50,000-gallon tanks.

McClellan Air Force Base, Sacramento, Calif.-----Waste lumber disposal contract expected to be completed by June 1968.

Vandenberg Air Force Base, Santa Barbara County, Calif.-----Vapor recovery valves on 4 underground fuel storage tanks.

Lowry Air Force Base, Denver, Colo.-----Dustless ash handling equipment installed at heating plant during 3d quarter fiscal year 1968. Refuse disposal accomplished by sanitary landfill operation.

Robins Air Force Base, Warner Robins, Ga.-----Building 230 connected to central heating plant, thereby eliminating 1 furnace problem. Open burning of scrap lumber temporarily terminated by salvage and landfill operation. Available land is limited so incinerator planned for fiscal year 1972.

Belleville Air Force Station, Belleville, Ill.-----Remedial action not required. Phaseout scheduled for July 1968.

Chanute Air Force Base, Rantoul, Ill.-----Open burning discontinued and sanitary landfill established July 1967.

Hanna City Air Force Station, Hanna City, Ill.-----Remedial action not required; phaseout scheduled for July 1968.

Sioux City Airbase, Sioux City, Iowa.-----Remedial action not required. Facilities being turned over to ANG and Sioux City effective September 1968.

Snow Mountain Air Force Station, Fort Knox, Ky.-----Cyclone separator no longer needed. Phaseout scheduled for July 1968.

Barksdale Air Force Base, Bossier City, La.-----Classified waste disintegrator installed. Construction scheduled to start before Dec. 31, 1968, on nonpollutant waste disposal system for a new composite medical facility. Design underway

Andrews Air Force Base, Camp Springs, Md.-----Contract for off-base refuse disposal eliminates need for incinerator. Design underway to convert boilers in building 1515 to oil.

L. G. Hanscom Field, P.L.N. 1949, Bedford, Mass.-----Smoke detection and recorder system accomplished in December 1967.

Westover Air Force Base, Chicopee, Mass.-----Open burning eliminated with sanitary landfill. Close monitoring of heat plant operation.

Calumet Air Force Base, Calumet, Mich.-----A & E design underway for plant expansion and fuel conversion.

Port Austin Air Force Station, 80 miles southeast of Saginaw, Mich.-----Fuel conversion to natural gas included in project to enlarge plant. Expected completion date September 1968.

Selfridge Air Force Base, Mount Clemens, Mich.-----Design in progress for fuel conversion to natural gas to be effected in early 1969.

Keesler Air Force Base, Biloxi, Miss.-----Installation of submerged inlet lines in 500-gal. gasoline storage tanks. Completed November 1967.

Aeronautical Chart and Information Center, St. Louis, Mo.-----Design completed and construction contract awarded in April 1968 for combination shredder-incinerator. Facility expected to be in operation by September 1968.

Kirksville Air Force Station, Kirksville, Mo.-----Do.

Omaha Air Force Station, Omaha, Nebr.-----Low sulfur No. 4 fuel oil purchased for building 33-42. New boilers fired with No. 2 fuel oil installed for buildings 27-43, 27-35, 28-19, and 28-34.

McGuire Air Force Base, Burlington County, N.J.-----ANG procuring low sulfur fuel oil to comply with emissions standards.

National Guard Air Base, Floyd Bennett Field, N.Y.-----Open burning discontinued. Refuse now deposited in sanitary landfill.

Plattsburgh Air Force Base, Plattsburgh, N.Y.-----Design for new boilers completed; advertised for bid.

Fortuna Air Force Station, Fortuna, N. Dak.-----Fuel conversion from coal to oil scheduled for July 1, 1968.

Grand Forks Air Force Base, Emerald, N. Dak.-----Design completed and project authorized for bid advertisement. (Conversion of heating plant to gas.)

Minot Air Force Station, Minot, N. Dak.-----Purchasing low sulfur oil to comply with emission standards.

Lockbourne Air Force Base, ANG Facility, Columbus, Ohio.-----

Wright-Patterson Air Force Base, Green County, Ohio.-----New incinerator installed in building 305, area B. Replaced all cones on mechanical collector for No. 2 boiler CHP 1240 (HTW). Contaminated POL to be sold rather than burned on base.

Altus Air Force Base, Altus, Okla.-----Refuse disposed off base in sanitary landfill operation.

Kingsley Field, Klamath Falls, Oreg.-----Submerged inlets on fuel tanks installed.

Greater Pittsburgh Airport, Pittsburgh, Pa.-----Submerged inlets on fuel tanks.

Willow Grove Air Reserve Facility, Willow Grove, Pa.-----No. 6 fuel oil containing 0.8 percent sulfur now being procured. Seeking oil containing 0.6 percent sulfur.

APPENDIX C—Continued
ANNUAL REPORT OF PROGRESS BY INSTALLATION DURING FISCAL YEAR 1968—Continued

Agency	Installation	Actions
Department of Defense—Continued Air Force—Continued		
Atomic Energy Commission	Carswell Air Force Base, Fort Worth, Tex.	Open burning of refuse eliminated using sanitary landfill. Commissary incinerator being used by base communications.
	Kelly Air Force Base, San Antonio, Tex.	Reclamation smelter has ceased operation.
General Services Administration	Hill Air Force Base, Ogden, Utah	Upgraded control equipment on classified document incinerator.
	National Reactor Testing Station, Bingham County, Idaho	1 photoelectric unit with alarm system installed on steam plant at EBR II site.
	Argonne National Laboratory, Du Page County, Ill.	Requested funds to convert plant to natural gas. Funds denied by Joint Committee on Atomic Energy.
	Burlington plant, Des Moines, Iowa	Contract for engineering and design let on May 1, 1968, to convert steam plant from coal to natural gas and standby fuel oil. To be completed by October 1969.
	Paducah Gaseous Diffusion Plant, Paducah, Ky.	Work started on rebuilding electrostatic precipitators on steam plant C-600.
	Bendix plant, Kansas City, Mo.	Equipment ordered to install gas afterburner and flue gas washer with stack damper in classified waste destructor in April 1968. Completion scheduled August 1968.
	Brookhaven National Laboratory, Suffolk County, N.Y.	Requested funds to convert steam plant to natural gas. Request denied by Joint Committee on Atomic Energy.
	Knolls Atomic Power Laboratory, Schenectady County, N.Y.	Changed fuel oil contract to less than 2 percent sulfur oil. Installed submerged filling inlet on 10,000-gal. storage tank. Currently establishing offsite disposal of wastes to replace open burning.
	Oak Ridge Operations Feed Materials Production Center, Fernald, Ohio.	Smoke density recorders installed in 3 of 4 stacks. Studies of electrostatic precipitator operation underway to determine compliance with Executive Order 11282.
	Oak Ridge Operations Office, Portsmouth Area Gaseous Diffusion Plant, Portsmouth, Ohio.	Stack sampling and other studies involving fuels still underway to evaluate economics of various remedial measures including electrostatic precipitation, smoke density recorders, and fly ash equipment.
	Savannah River Operations Office, Savannah River Plant, Aiken and Barnwell Counties, S.C.	Sanitary landfill being developed to eliminate open burning. Study regarding need for electrostatic precipitators in progress.
	Oak Ridge National Laboratory, Oak Ridge, Tenn.	Vapor recovery and control system installed to control gasoline vapor loss.
	Oak Ridge Operations, Oak Ridge Gaseous Diffusion Plant, Oak Ridge, Tenn.	Funds budgeted for installation of smoke density recorders. Steam plant being studied regarding need for electrostatic precipitators and smoke density recorders.
	Oak Ridge Operations, Oak Ridge Steam Plant, Building 1916-T-2A, Oak Ridge, Tenn.	Study underway to determine feasibility of installing gas-fired boilers to eliminate smoke problem in residential area.
	Pantex plant, Amarillo, Tex.	Sanitary landfill operation installed to eliminate open burning of 3.6 tons of refuse per day.
	Richland Operations Office, Hanford Reservation, Adams, Benton, Grant and Franklin Counties, Wash.	17 smoke density monitors have been procured for use at this plant.
	Federal Center Building 47, Denver, Colo.	Fuel conversion construction contract awarded in April 1968. Completion scheduled for Nov. 15, 1968. Converting from coal to gas and No. 2 fuel oil.
	Englewood Postal Station, Chicago, Ill.	Fuel conversion project out on bid. Coal to gas heating plant.
	Post Office and Courthouse, Albany, N.Y.	Funds requested for conversion to gas and No. 2 oil. Design completed.
	Bronx Central Station Post Office, Bronx, N.Y.	Project for conversion to No. 2 oil underway.
	Federal Office Building, 29th St. and 3d Ave., Brooklyn, N.Y.	Conversion of boilers to gas and No. 2 fuel oil underway. Completion date, Oct. 1, 1968.
	Federal Office Building, 35 Ryerson St., Brooklyn, N.Y.	Do.
	Post Office, Flushing, N.Y.	Do.
	Post Office, Jamaica, N.Y.	Do.

Department of Commerce	Madison Square Post Office, New York, N.Y. Federal Office Building, 641 Washington St., New York, N.Y. Post office, Rochester, N.Y. North Philadelphia Postal Station, Philadelphia, Pa. 5000 Wissachickon Ave., Philadelphia, Pa. National Bureau of Standards, Gaithersburg, Md. Hoboken terminal, Hoboken, N.J.	Do. Do. Conversion of boilers to gas and No. 2 fuel oil initiated. Conversion of boiler from No. 4 to No. 2 oil completed. Conversion of boiler to gas and No. 2 fuel oil underway. Contract has been let for conversion of heating plant to gas and standby fuel oil. Property is under lease to Port of New York Authority. Authority has budgeted to convert to No. 2 fuel oil in summer of 1968. Lower sulfur fuel oil now being used. A contract has been let to study the feasibility of using a combination gas-oil fired high-pressure boiler or converting to No. 2 fuel oil. Multiple chamber incinerator has been installed replacing single chamber unit. Converted to low sulfur No. 5 oil. Open burning discontinued and sanitary landfill operating. Bids on market to obtain lower sulfur fuel oil.
Department of Health, Education, and Welfare: Public Health Service.	U.S. Merchant Marine Academy, Kings Point, Long Island, N.Y. Indian hospital, Phoenix, Ariz. Outpatient clinic, Chicago, Ill. PHS hospital, Lexington, Ky. Northeastern Radiological Health Laboratory, Winchester, Mass. PHS hospital, Boston, Mass. PHS hospital, Staten Island, N.Y. Quarantine station, Staten Island, N.Y. Outpatient clinic, Philadelphia, Pa. Northeast Marine Health Sciences Laboratory, Narragansett, R.I. PHS hospital, Norfolk, Va. St. Elizabeth's Hospital, Washington, D.C. Gloucester Coast Guard Base, Gloucester City, N.J. Coast Guard Training Center, Cape May, N.J. New York Coast Guard Base, Governors Island, N.Y. Elizabeth City Coast Guard Air Base, Elizabeth City, N.C.	Do. Converted to No. 2 fuel oil. Design for eventual conversion to gas is 80 percent complete. Converted to No. 2 fuel oil. Converting to lower sulfur fuel oil. Invitation to bid is on the market for lower sulfur fuel oil. Converted to No. 2 fuel oil. Contracts awarded for smoke meters on boilers, installation of afterburner, barometric damper, overfire ventilation, and burners in main incinerator. Heating system converted from No. 5 residual fuel oil to No. 2 distillate oil. Open burning of refuse has been discontinued. Refuse now compacted, collected, and disposed of by refuse service. Partial conversion from residual fuel oil to No. 2 distillate fuel oil. Will be completed when funds are available. Open burning of waste discontinued. Use of compactors and public disposal facilities accomplished. Incinerator out on bid to eliminate open burning. Feasibility study in progress to determine modifications of heating plant. Stack sampling to be done to check emissions from No. 5 fuel oil. Preliminary investigation for heating plant modification to include air pollution abatement equipment has been made. An incinerator is being considered. Heating plant is being converted to No. 2 fuel oil. Boilers have been replaced with liquefied petroleum gas fired units for each building. Coal fired boilers are abandoned. Now converting centralized heating plant to No. 2 fuel oil. Will be converted to No. 2 fuel oil for the heating plant. Now converting to No. 2 fuel oil for the heating plant. Scheduled to convert from coal to natural gas in fiscal year 1969. Incinerators programmed for 1971 and 1974 fiscal year for Desert View, North Rim, and South Rim. Parties operating 9 of 13 locations under lease with Bureau of Sport Fisheries and Wildlife. have been notified to comply with Executive Order 11282. 4 other installations are to use No. 2 fuel oil or gas. Open burning has been eliminated and a sanitary landfill installed.
Department of Transportation		
Department of the Interior: Bureau of Indian Affairs.	Mt. Edgecumbe Boarding School, Sitka, Alaska Chinle Agency Headquarters, Chinle, Ariz. Hopi Indian Agency Headquarters, Reams Canyon, Ariz. Standing Rock Boarding School, Fort Yates, N. Dak. Seneca Indian School, Wyandotte, Okla. Oglala Community School, Pine Ridge, S. Dak. Kyle Day School, Pine Ridge, S. Dak. Pierre School, Pierre, S. Dak. Intermountain School, Brigham City, Utah National Park Service, Grand Canyon National Park, Grand Canyon, Ariz. Crab Orchard NWR, Carterville, Ill.	
Bureau of Sport Fisheries and Wildlife.		

APPENDIX C—Continued

ANNUAL REPORT OF PROGRESS BY INSTALLATION DURING FISCAL YEAR 1968—Continued

Agency	Installation	Actions
Smithsonian Institution.....	National Zoological Park, Washington, D.C.....	Planning funds made available to GSA for heating study preliminary to phasing-out coal plant and conversion to gas. Improvements made in stack gas washer on incinerator. Plans for all-weather operation of this scrubber being drawn.
Department of Justice: Bureau of Prisons.....	Federal Correctional Institution, Lompoc, Calif.....	Engineering study planned for waste disposal practices.
	Southwest Regional Office, San Pedro (Terminal Island), Calif.....	Converted from high sulfur fuel oil to No. 2 fuel oil.
	Federal Correctional Institution, Terminal Island, Calif.....	Engineering study planned.
	Federal Youth Center, Englewood, Colo.....	Engineering study planned for waste disposal practices.
	Federal Correctional Institution, Danbury, Conn.....	Engineering study to be conducted concerning refuse disposal practices.
	Federal Correctional Institution, Tallahassee, Fla.....	Engineering study planned concerning refuse disposal practices.
	U.S. Penitentiary, Marion, Ill.....	Do.
	U.S. Penitentiary, Terre Haute, Ind.....	Do.
	U.S. Penitentiary, Leavenworth, Kans.....	Engineering study underway. Funds for 2 incinerators to be requested in fiscal year 1970 budget.
	Federal Youth Center, Ashland, Ky.....	Engineering study planned concerning waste disposal practices.
	Federal Correctional Institution, Sandstone, Minn.....	Do.
	Medical Center for Federal Prisoners, Springfield, Mo.....	Do.
	U.S. Penitentiary, Lewisburg, Pa.....	Do.
	Federal Correctional Institution, La Tuna, Tex.....	Engineering survey planned concerning refuse disposal practices.
	Federal Correctional Institution, Seagoville, Tex.....	Do.
	Federal Reformatory, Tarkenton, Tex.....	Do.
	Federal Reformatory, Petersburg, Va.....	Engineering study to be conducted concerning refuse disposal practices, excessive smoking from boiler plant, need for new boilers which will be gas-fired or coal with suitable control equipment.
	U.S. Penitentiary, McNeil Island, Steilacoom, Wash.....	Engineering study of waste disposal to be made.
	Federal Reformatory for Women, Alderson, W. Va.....	Engineering study to be made on boiler plant and refuse disposal practices.
	National Training School for Boys, Morgantown, W. Va.....	New facility. Engineering study planned for refuse disposal.
National Aeronautics and Space Administration.....	Michoud Assembly Facility, New Orleans, La.....	Funds requested for design in fiscal year 1969. Scrubbers, filters, and incinerators needed for unspecified operations.
	Goddard Space Flight Center, Greenbelt, Md.....	Design for gas conversion of boiler plant has been completed.
Post Office Department.....	Langley Research Center, Hampton, Va.....	Study of heating plant to burn natural gas.
	Post office, Fort Wayne, Ind.....	Converted heating plant to burn natural gas.
	See list of installations ¹	Trash removal contracts were instituted to eliminate open burning or faulty incineration practices on premises of Post Office installations. The contracts specify that ultimate disposal of materials removed must comply with local air pollution control regulations.
Tennessee Valley Authority.....	National Fertilizer Development Center, Muscle Shoals, Ala.....	Improvements reported affect the phosphate complex, ammonia complex and also reflect the establishment of a digital recording meteorological station as part of an air monitoring network. Specific improvements include reduction in dusts, fluorides, phosphorus oxides, ammonia, acids, and oxides of nitrogen. Further reduction of dusts and fluorides are scheduled for the current year.

Colbert Steamplant, Colbert, Ala.....	Efforts are being made to up-grade the efficiency of electrostatic precipitators at this plant. Ammonia injection for conditioning flue gas was unsuccessful.
Widows Creek Steamplant, Stevenson, Ala.....	Ammonia injection systems to condition flue gas at units 7 and 8 were installed and resulted in improved efficiency of electrostatic precipitators. Work being continued toward further improvement.
Shawnee Steamplant, Paducah, Ky.....	Contract awarded for design and construction of 10 electrostatic precipitators. Tentative installation scheduled during outages occurring between August 1968 and December 1969.
Gallatin Steamplant, Gallatin, Tenn.....	Contract awarded for design and construction of electrostatic precipitators. Installation scheduled during March-November 1969.
Power Building, Chattanooga, Tenn.....	Coal-fired boiler has been replaced with electric heating equipment.
VA Hospital, Grand Junction, Colo.....	Construction to convert boilers to gas-fired units underway.
VA Center, Dublin, Ga.....	Do.
VA Center, Des Moines, Iowa.....	Construction for conversion of boilers from coal to gas underway.
VA Hospital, Knoxville, Iowa.....	Do.
VA Hospital, Louisville, Ky.....	Discontinued incineration, disposing of waste by contract collection.
VA Hospital, Castle Point, N.Y.....	Construction for conversion of boilers to gas-fired units underway.
VA Hospital, Montrose, N.Y.....	Design for conversion of boiler from coal to gas completed.
VA Hospital, Durham, N.C.....	Construction for conversion of boilers from coal to gas underway.
VA Hospital, Fayetteville, N.C.....	Do.
VA Hospital, Fargo, N. Dak.....	Preliminary plans for replacement of boiler system completed. Discontinuance of open burning and installation of sanitary landfill completed.
VA Hospital, Chillicothe, Ohio.....	Project for boiler replacement completed. New boilers are gas fired.
VA Hospital, Roseburg, Oreg.....	Boiler replacement completed. New boilers are gas fired.
VA Domiciliary, White City, Oreg.....	Replacement of coal-fired boilers with gas-fired boilers completed.
VA Hospital, Aspinwall, Pa.....	Construction for conversion of boiler to gas-fired units underway.
VA Hospital, Erie, Pa.....	Boiler replacement construction underway. New boilers to be gas fired.
VA Hospital, Columbia, S.C.....	Boiler plant replacement preliminary plans underway.
VA Hospital, Mountain Home, Tenn.....	Open burning discontinued. Sanitary landfill has been completed.
VA Hospital, American Lake, Wash.....	Construction for conversion of boiler from No. 6 oil to gas underway.
VA Hospital, Spokane, Wash.....	Project drawings for conversion of boiler from coal to gas have been completed.
VA Hospital, Vancouver, Wash.....	Boiler replacement projects completed. New boilers are gas fired.
VA Hospital, Huntington, W. Va.....	Design for conversion of boilers from coal to gas completed.
VA Hospital, Madison, Wis.....	Construction to convert boiler to gas-fired units underway.
VA Hospital, Tomah, Wis.....	Construction has started on a new boiler plant.
VA Hospital, Perry Point, Md.....	Boiler replacement completed. New boilers are gas fired.
VA Hospital, West Roxbury, Mass.....	Construction to convert boilers from coal to gas underway.
VA Hospital, Ann Arbor, Mich.....	Construction for conversion of boiler to gas-fired units underway.
VA Hospital, Battle Creek, Mich.....	Installation of new gas-fired boiler completed. Construction for replacing refuse incinerator underway.
VA Hospital, Dearborn, Mich.....	
Veterans' Administration.....	

APPENDIX C—Continued
ANNUAL REPORT OF PROGRESS BY INSTALLATION DURING FISCAL YEAR 1968—Continued

Agency	Installation	Actions
Veterans' Administration—Continued		
	VA Hospital, Iron Mountain, Mich.-----	Construction for conversion of boilers to gas-fired units underway.
	VA Hospital, Jefferson Barracks, St. Louis, Mo.-----	Do.
	VA Hospital, Kansas City, Mo.-----	Do.
	VA Hospital, Lyons, N.J.-----	Do.
	VA Hospital, Lexington, Ky.-----	Do.
1 List of installations:		
Alabama:	California—Continued	Iowa—Continued
Boaz	Castroville	Des Moines
Jackson	El Cajon	Carrier annex
Guin	Escalon	East 14th St.
Georgiana	Fairfield	South Des Moines station
Moulton	Felton	Urbandale branch
Arkansas:	Lathrop	University Pl. station
Des Ark	Livingston	Tama
Osceola	Napa	Waterloo
Arizona:	New Castle	Evansdale branch
Apache Junction	Orangeville	Washburn branch
Sedona	Oriand	Maryland: Beltsville
California:	Pinedale	Minnesota:
Antioch	Soledad	Canby
Apple Valley	Solvay	Excelsior
Aptos	Sunnyside	Mound
Atascadero	West Sacramento	Sauk Rapids
Benicia	Hawaii: Honolulu	Silver Bay
Broderick	Iowa:	Missouri:
Capitola	Davenport	Hayti
		Imperia
		Missouri—Continued
		O'Fallon
		Portageville
		East Prairie
		Salisbury
		Sarcozie
		North Dakota:
		Mandan
		Minot
		Tennessee:
		Centerville
		Jamestown
		Mountain City
		Parsons
		Wisconsin:
		Menomonee Falls
		New Berlin
		New London
		New Richmond
		Oak Creek
		East Troy
		Randolph

APPENDIX C

RESEARCH AND DEVELOPMENT ACTIVITIES OF THE NATIONAL AIR POLLUTION CONTROL ADMINISTRATION

The National Air Pollution Control Administration's research and development program has two major thrusts: (1) the development of air quality criteria as a technical basis for standards and (2) development of technology to control the sources and emissions of pollutants.

The work is carried out by the National Air Pollution Control Administration through studies in its own laboratories, contracts with private research corporations and non-profit institutions, interagency agreements supporting research in other Federal agencies, research grants to non-profit organizations, and survey and demonstration grants to a variety of organizations. This work is conducted under Section 104 and other provisions of the Air Quality Act. Tables 1 and 2 summarize the estimated resources devoted to the National Air Pollution Control Administration research and development program.

SECTION 104

Section 104 of the Air Quality Act of 1967 directed that special emphasis be placed on research and development into new and improved methods for the prevention and control of air pollution resulting from the combustion of fuels. Stationary and vehicular sources of pollution are included in this area of research activity, and contractual and cooperative research and development undertakings with industrial organizations are emphasized.

Control of pollutant emissions from stationary sources is an especially difficult problem because quantities emitted each year are steadily increasing and because of the great diversity and variety of sources. The approach that is being followed in conducting a research and development effort for dealing with stationary sources consists of: (1) the development of systems and processes to control specific pollutants such as sulfur oxides, nitrogen oxides, and particulates; (2) systems surveys to define the pollution problems of specific industries and to cooperatively develop control approaches for these industries, such as primary smelters; and (3) the continuous development of new and improved air cleaning devices for use on a variety of sources. With this approach, the National Air Pollution Control Administration has elicited interest on the part of many industrial companies in the United States who have the capability of working on some phase of the problem. At present, the largest single research and development effort being carried out is in the area of sulfur oxides control.

TABLE 1.—ESTIMATED RESOURCES FOR RESEARCH AND DEVELOPMENT ACTIVITIES OF THE NATIONAL AIR POLLUTION CONTROL ADMINISTRATION, FISCAL YEAR 1969

[Dollars in thousands]							
	Sec. 104 funds			Nonsec. 104 funds			Activity total
	Positions	Contracts	Intra-mural	Contracts	Intra-mural	Grants	
Air quality and effects definition	320			\$5,562	\$6,206	\$5,275	\$17,043
Air quality	150			3,060	2,909	2,900	8,869
Effects	170			2,502	3,297	2,375	8,174
Control	198	\$15,820	\$1,430	4,121	2,454	2,486	26,311
Vehicle emission control	48	2,051	177	40	761	1,043	4,072
Stationary emission control	150	13,769	1,253	4,081	1,693	1,443	22,239
Other	30	450		566	570	670	2,256
NAPCA total	548	16,270	1,430	10,249	9,230	8,431	45,610

TABLE 2.—ESTIMATED RESOURCES FOR RESEARCH AND DEVELOPMENT ACTIVITIES OF THE NATIONAL AIR POLLUTION CONTROL ADMINISTRATION, FISCAL YEAR 1970

[Dollars in thousands]

	Positions	Sec. 104 funds		Nonsec. 104 funds			Activity total
		Contracts	Intramural	Contracts	Intramural	Grants	
Air quality and effects definition.....	310			\$6,024	\$6,490	\$5,680	\$18,194
Air quality.....	150			3,019	3,140	3,120	9,279
Effects.....	160			3,005	3,350	2,560	9,815
Control.....	210	\$21,150	\$1,300	2,790	3,110	3,600	31,950
Vehicle emission control.....	52	2,540	160	40	925	1,400	5,065
Stationary emission control.....	158	18,610	1,140	2,750	2,185	2,200	26,885
Other.....	40	450		1,136	878	720	3,184
NAPCA total.....	560	21,600	1,300	9,950	10,478	10,000	53,328

¹ Includes carryover of \$1,000,000.

During 1969, Section 104 research and development projects will concentrate on pilot and prototype scale work on processes for the removal of sulfur from flue gases, including dry limestone injection, wet limestones scrubbing, alkalized alumina, and molten carbonate scrubbing, and coal desulfurization by pyrite-coal conversion. Also included are studies on the availability of low-sulfur coals.

During 1970, the sulfur oxides control effort will continue to require and receive a substantial degree of support. The full-scale National Air Pollution Control Administration-Tennessee Valley Authority limestone injection demonstration project, begun in 1968, will be fully operational as will prototype units for pyrite coal cleaning and wet limestone scrubbing.

Work will continue on new combustion processes with emphasis on completion of the pilot work on fluid bed combustion being conducted jointly with the Office of Coal Research, Bureau of Mines. Comprehensive systems analysis of several important non-combustion sources of sulfur oxides emissions will be completed in 1969 and hardware development programs started in 1970 in cooperation with industry. Pollution from this source accounts for about 20 percent of sulfur oxides emissions and presents significant problems in many urban areas.

An analytical study on the control of nitrogen oxides will be completed in FY 1969 and a research and development program will be initiated which will lead to new design concepts for combustion equipment and flue gas cleaning processes for industrial sources of nitrogen oxides. Efforts also include initiating an accelerated nitrogen oxides control program and a comprehensive systems study of the stationary sources of this pollutant.

Other projects are directed at finding improved methods for the control of particulates and expanding studies on the feasibility of using fabric filters to control flyash emissions from power plants. An intramural study, undertaken to develop improved wet scrubbing techniques, will be continued.

The three primary objectives of the automotive research program for control of vehicle emissions are: (1) to stimulate optimum activity by the private sector in developing control technologies; (2) to fill the research gap areas that are not receiving attention elsewhere; and (3) to develop a technical basis for establishing future Federal emission standards.

Since gasoline-powered vehicles are more numerous than any other kind of vehicle and emit more types and quantities of pollutants, they have been given the highest research and development priority. Work has concentrated on the control of exhaust emissions, with emphasis on carbon monoxide, hydrocarbons, and nitrogen oxides; the control of evaporative losses; and the development of measuring techniques. Efforts are also being directed at the control of exhaust emissions from diesel engines including smoke and odor control. A significant cooperative research program, begun in 1968 and expanded during 1969, consists of projects funded jointly by the Automobile Manufacturers' Association, the American Petroleum Institute, and the National Air Pollution Control Ad-

ministration. Approximately 30 projects are to be carried out over a three-year period.

Three major work areas within the motor vehicle research and development program, initiated during 1969, will move into the hardware development and pilot evaluation stages during the coming year. Prototype devices for the control of particulate emissions from vehicles, including lead, will be designed, constructed, and tested in the laboratory. Work on nitrogen oxides control systems will move from the research laboratory to the field for fleet testing to observe their durability, economics, and effect on vehicle operation. Hardware development studies will be undertaken on carburetors, electronic ignition systems, fuel injection, engine configurations, and fuel properties. Work will continue on emission control efforts for non-automotive transportation sources, especially aircraft.

Due to the inherent limitations of the internal combustion engine, with respect to emission control, it is important that its potential for a pollution-free automotive power source be explored. Feasibility studies of all possible power sources for motor vehicles and an outline of research and development gap areas have been prepared for the most promising unconventional power systems. Limited studies initiated in FY 1969 on external combustion burners and design of a Rankine-cycle engine for passenger cars will be intensified in FY 1970.

SECTION 103 RESEARCH AND DEVELOPMENT ACTIVITIES

Research and development activities conducted under Section 103 and other provisions of the Air Quality Act (other than Section 104) are described below. Intramural and contractual research is described first, followed by a description of the grants programs.

Criteria and standards

Air quality criteria are scientific statements which describe the known effects of pollutants on health and welfare. They are the basis for establishing legal standards for the emission and accumulation of pollutants. Both criteria and standards are critical ingredients in the process of abatement and control as established by the Air Quality Act of 1967. The air pollution research and development program geared toward their development includes health effects studies, economic effects studies, and the accumulation of data on pollution levels for purposes of correlation with observed ranges of effects.

The need for air quality places a heavy demand on biological research. As part of the program of expanding and refining air quality criteria in 1970, work will continue on the effects of air pollution on the sensitive segments of the population, such as the aged, the very young, and those with heart, lung, or other physical defects. Work will also include studies on the genetic and prenatal influence of air pollutants, and on behavioral toxicology. Efforts will be made to define levels which can be classified as representative of an episode and to discover prophylactic measures to use on sensitive populations.

The limited clinical research program, established in 1969, will be accelerated with initial activities stressing combined effects of air pollution and respiratory infections, the identification of aeroallergens, prophylactic measures for use in episodes, and the delineation of air concentration and body burdens for selected metals. Work will continue on the development of related health effects data necessary to establish air quality criteria for additional classes of pollutants. After completion of criteria on carbon monoxide organics and photochemical oxidants, intensive efforts will be directed at developing information for criteria on odors, organic, carcinogens, aeroallergens, and the metallic components of fuel additives, including lead.

Additional support will be given to conducting epidemiological studies, since they are especially productive in identifying sensitive segments of the population. These studies will help to determine the cumulative effects of the types of pollutants which may present continuous or intermittent dangers to human health.

The results of earlier work have revealed that considerable economic damage is wrought by air pollution on vegetation, livestock, building materials, fabrics, and visibility. Such welfare effects will continue to receive attention since they represent important elements in the development of air quality criteria.

The 1970 program will emphasize the synergistic effects of sulfur oxides and oxidants on important crops along the East Coast; the socioeconomic impact

of odors; the effects of common pollutants on fabrics, agricultural crops, building materials, artworks, architectural coatings; and the cleaning costs associated with air pollution. A limited national monitoring network will be initiated to measure pollution effects and to allow calculation of the cost of pollution to industrial communities.

The costs inherent in achieving effective controls will be evaluated through a series of joint studies with industry. Emphasis in 1970 will be on control costs for sulfur oxides, odors, organics, and selected particulate emissions. Available cost data will be evaluated with information on abatement and control programs in order to develop current and projected national costs for air pollution control. The impact on selected industries and distribution between capital and operating costs will be analyzed.

Air monitoring programs are important to verify air pollution episodes, to assess enforcement efforts, and to provide background data for problem identification and standard setting. During 1970, sampling will be expanded to include additional heavy metals, organic carcinogens, radioactive contaminants, hydrogen sulfide, and fluorides. Limited sampling will be initiated on aerollergens, asbestos, and pesticides. Emission inventories will be compiled of the most important pollutants in about 110 major urban areas and a close integration of this activity with developing State and local monitoring activities will be maintained.

Studies on air contamination and the degree of control needed in special situations will be continued, including indoor levels of carbon monoxide and lead in buildings over or close to major highways; pesticide levels in small communities and agricultural areas; and rocket exhaust contaminants in aerospace communities. Data from such studies will lead to quantitative parameters that will permit incorporation of air pollution control provisions in manuals for use by highway and urban planners.

Engineering and physical sciences

A variety of research programs on the chemical, meteorological, and related physical science aspects of air pollution will be expanded to provide information needed to develop air quality criteria. Besides the intramural research effort carried out directly by the Administration, extensive use is made of the technical resources of other Federal agencies, through interagency contracts, educational institutions, and private industry. The combination of intramural and extramural efforts in the physical sciences provides essential background information, test methods, and understanding of the physical-chemical, engineering, and meteorological relationships essential in defining the extent and importance of potential new pollutants, setting standards, and devising means by which to control pollution.

In 1970, chemical and physical research efforts will be expanded to support limited studies of approximately eight additional pollutants that require significant investigation before abatement and control activities can begin. Investigations will continue to seek a means for applying aerospace instrumentation techniques to air pollution control. Analytical studies initiated in 1969 will move into the more expensive development phases, including prototype field demonstration work. Projects will include remote source monitors for sulfur oxides, particulates, hydrocarbons, and nitrogen oxides; aerial survey methods for oxidants, sulfur oxides, and particulates; long-path ambient air monitors; remote instruments for measuring wind speed and temperature changes with altitude; and improved integrated air sampling stations for a variety of important gases.

Other research will be directed at developing analytical techniques for detecting organic carcinogens, sulfuric acid, aeroallergens, asbestos, and heavy metals with emphasis on simplification of existing laboratory methods for use in routine air monitoring. Field studies will be initiated to define current levels of high priority pollutants in selected urban communities. A high priority will be given to field studies investigating the various photochemical reactions in the atmosphere, including initiation of an investigation of East Coast photochemical smog reactions. A long-range program to define the geophysical and some of the ecological impacts of air pollution will be begun.

As standards are established and enforcement activities accelerate under the processes of the Act, increased emphasis will be placed on promulgation of standard methods for air analysis and source sampling. Early in 1970 a

manual of recommended methods for the analysis of most of the important pollutants will be published and recommended standard methods for air analysis will be published for the pollutants for which criteria will have been issued.

New efforts in combustion research, catalytic chemistry, and electrochemistry will be undertaken during the year to support the applied research studies on stationary and vehicle emissions. This effort will also assist in providing a technical base for studies on unconventional power sources for vehicles with low pollution potential.

Meteorological activities will continue with development work proceeding on new and improved varieties of computer models for prediction of the diffusion and transport of pollutants in the atmosphere. These models are becoming increasingly important factors in translating air quality needs into emission standards for control purposes, and they are one of the important cornerstones used to define Air Quality Control Regions. Emphasis will be given to the development of better prediction models for episodes, micro-models for highway design and urban planning purposes, long-range intercity pollution transport models, and the simplification of existing mathematical models so that they may be used more routinely by control agencies.

Also during 1970, work will be completed on the evaluation of the effectiveness of tall stacks in hilly terrain. Similarly, an investigation will be conducted jointly with industry in areas where flat terrain exists and land-sea breezes prevail. Other research activities which will continue during the year will include air pollution potential climatology studies, and studies of intercity transport. To provide increased understanding of transport pollutants over long distances, investigations are currently being conducted on long-range tracer experiments using isotope tracer systems.

Research grants support the fundamental research needed to explore new concepts and innovations in every aspect of air pollution control. They are a valuable tool in utilizing the scientific capabilities of researchers in universities and other non-profit research organizations. Research grants stimulate the scientific community to respond to the need for creative research in air pollution control.

In 1969 grants are being awarded for a broad range of scientific investigations, including studies in the following areas: (1) air pollution and respiratory infections to determine the true pathogenesis of human air pollution disease and to see what actual respiratory changes occur from chronic and prolonged exposure to air pollutants at realistic concentrations; (2) the influence of pollutants on visibility for purposes of developing an understanding of and defining the factors which bring about reduced visibility in urban areas, even in the absence of fog and high humidity; and (3) the effect of air pollutants on lung clearance to determine the capability of the lungs in clearing themselves of different kinds of aerosols containing pollutants which might commonly exist in urban air.

In 1970 research efforts will concentrate on providing the background information and methodology for establishing better air quality standards, especially for air pollutants such as fuel additives and other heavy metals, and on theoretical and fundamental bases for new, more economical control technologies with emphasis on new combustion processes, mathematical models for existing control concepts such as scrubbers, electrostatic precipitator; afterburners, and energy exchanges in the atmosphere to allow better dispersion modeling. Also planned are studies on behavioral toxicology, the physical-chemical basis for gas-particulate synergism, socio-economic analysis, and the relationship between air quality and body build-up of cumulative pollutants. Grants to new young investigators in selected fields will be encouraged in order to stimulate new ideas and an interest in air pollution.

Survey and demonstration grants

This activity provides for support for developing technological and operational innovations and demonstrating them for practicability and effectiveness. Survey and demonstration grants are awarded to a variety of organizations on a cost-sharing basis; organizations other than air pollution control agencies, which have a potential contribution to air pollution control, are eligible for grants. Projects in 1970 will include demonstrations of cost-benefit models of pollution control in selected urban area, of emergency episode control programs, of new and improved control techniques, and of control of sulfur and nitrogen oxides at intermediate size combustion units.

NAPCA ACTIVE CONTRACTS

Contractor and contract No.	Purpose	Project officer and division	Amount
ADGO, Inc., Cincinnati, Ohio; CPA 22-69-49	An automatic air pollutant controller for plant exposure chambers	D. Tingey, EER	\$8,537
Advanced Metals Research Corp., Burlington, Mass.; CPA 22-69-26	Electron microprobe analysis of atmospheric aerosols	J. Wagman, C. & P.	14,060
AeroChem Research Laboratories, Inc., Princeton, N.J.; CPA 22-69-11	Feasibility study for the development of a multifunctional emission detector for the following air pollutants: carbon monoxide, nitric oxide, and sulfur dioxide.	R. K. Stevens, C. & P.	40,245
Aerojet General Corp., El Monte, Calif.; PH 86-68-77	Applicability of aqueous solutions to the development of new processes for removing SO ₂ from flue gases.	G. L. Huffman, PCE	251,833
Aerojet General Corp., El Monte, Calif.; CPA 22-69-22	Systems evaluation of refuse as a low sulfur fuel.	R. C. Lorentz, PCE	344,970
Air Pollution Control Association, Pittsburgh, Pa.; PH 86-66-96	Provide abstracts and indexing terms of current literature on air pollution relating primarily to the engineering and physical sciences.	G. O. Chapman, OTIP	162,033
Air Preheater Co., Inc., Wellsville, N.Y.; PH 22-68-51	Evaluation of fabric filter as chemical contractor for control of sulfur dioxide from flue gases.	D. L. Harmon, PCE	135,705
Alabama, University of Birmingham, Ala.; PH 86-67-39	Alabama respiratory disease and air pollution study	C. M. Shy, HER	130,522
Albany Medical College, Albany, N.Y.; CPA 22-69-10	Detection of hearing impairment by exposure to carbon monoxide	W. J. Baldrige, HER	45,000
Albert Einstein College of Medicine of Yeshiva University, Bronx, N.Y.; PH 86-66-122	Perform an epidemiological study of air pollution in New York City	E. Landau, OPD	120,200
Allied Chemical Corp., Morristown, N.J.; PH 22-68-24	Development of new processes for removing SO ₂ from flue gases	G. L. Huffman, PCE	98,225
American Society for Testing and Materials, Philadelphia, Pa.; CPA 22-69-2	Preparation of summary document of the International Conference of Air Quality Criteria	E. Landau, OPD	4,000
AVCO Corp., Wilmington, Mass.; PH 86-67-51	Preparation of criteria for removal of SO ₂ from flue gas	R. P. Hangebrauck, PCE	183,164
Avis Rent-A-Car System, Inc., Garden City, N.Y.; PH 22-68-21	Motor vehicle surveillance rental fleet study	D. Pinkert, abatement	4,524
Babcock & Wilcox Co., Cincinnati, Ohio; PH 86-67-127	Pilot-plant investigation to evaluate potential of direct limestone-dolomite additive injection for control of sulfur dioxide from combustion flue gas.	R. H. Borgwardt, PCE	379,814
Barringer Research, Ltd., Rexdale, Ontario; PH 22-68-44	Test program of optical measurements of SO ₂ and NO ₂	I. S. Nader, C. & P.	50,342
Barringer Research, Ltd., Rexdale, Ontario; PH 22-68-47	Aerial survey and mapping of NO ₂ in the Chattanooga, Tenn., area	H. H. Slater, abatement	10,180
Battelle Memorial Institute, Columbus, Ohio; PH 86-67-109	To conduct studies and investigations of power sources for vehicles	R. C. Stahman, MVRD	49,000
Battelle Memorial Institute, Columbus, Ohio; PH 86-67-115	Reaction kinetics of limestone dolomite with sulfur dioxide in a disperse solid contactor	R. H. Borgwardt, PCE	257,260
Battelle Memorial Institute, Columbus, Ohio; PH 22-68-54	Development of a sampling and analysis method to determine asbestos fibers in air monitoring program samples	G. B. Morgan, AQED	23,300
Battelle Memorial Institute, Columbus, Ohio; PH 22-68-65	Systems analysis study of the integrated iron and steel industry	N. G. Edmisten, EER; D. R. Monti, PCE	228,259
Battelle Memorial Institute, Columbus, Ohio; PH 86-68-84	Performance of scientific, engineering, technical, and related services	D. R. Monti, PCE	290,000
Battelle Memorial Institute, Columbus, Ohio; PH 86-68-88	Cost utilization models for SO ₂ control processes	do	69,510
Battelle Memorial Institute, Columbus, Ohio; CPA 22-69-9	Study of influence of fuel atomization, vaporization, and mixing processes on pollutant emissions from motor vehicle powerplants	G. D. Kittredge, MVRD	50,000
Battelle Memorial Institute, Columbus, Ohio; CPA 22-69-24	Analysis of incinerator effluent collected in Greenburg-Smith impingers and carbonyl sampling train	J. J. Sableski, abatement	3,665
Battelle Memorial Institute, Columbus, Ohio; CPA 22-69-33	Electron microprobe analysis of atmospheric aerosols	J. Wagman, C. & P.	12,295
Battelle-Northwest, Richland, Wash.; PH 22-68-19	Applicability of organic liquids to the development of new processes for removing sulfur dioxide from flue gases	L. Stankus, PCE	22,190
Battelle-Northwest, Richland, Wash.; PH 22-68-61	Investigate the oxidative nature of air pollutants and their mechanism of effecting obstructive respiratory diseases	S. D. Lee, HER	116,358
Bechtel Corp., San Francisco, Calif.; PH 86-67-224	Process costs and economic study of pyrite-coal utilization	T. K. Janes, PCE	104,170
Bechtel Corp., San Francisco, Calif.; PH 22-68-67	Prototype study of limestone scrubbers for sulfur dioxide and dust removal systems	R. E. Harrington, PCE	159,645

Bendix Corp., Ann Arbor, Mich.; CPA 22-69-55.....	Long-path spectrophotometric instrumentation for in-situ monitoring of gaseous pollutants in the urban atmosphere.....	J. Nadar, C. & P.....	113,950
Bituminous Coal Research, Inc., Monroeville, Pa.; PH 86-67-139.....	Evaluation of coal-cleaning methods and techniques for removal of pyrite sulfur from fine-size coal.....	T. K. Janes, PCE.....	221,034
Bolt, Beranek & Newman, Cambridge, Mass.; PH 22-68-3.....	Determine the feasibility of applying an acoustical sounding technique to obtain vertical profiles of wind and temperature and atmosphere over urban areas.....	C. Hosler, meteorology.....	24,833
Bolt, Beranek & Newman, Cambridge, Mass.; CPA 22-69-29.....	A critical literature review of atmospheric haze in relation to air pollution.....	J. Wagman, C. & P.....	6,485
California State Department of Public Health, Berkeley, Calif.; PH 86-68-35.....	Preparation of reports and technical review of PHS reports.....	R. Larsen, CS.....	206,711
California, University of Irvine, Calif.; PH 86-68-28.....	Basic curriculum in air pollution and its control, developed in computer-assisted learning mode.....	C. R. Sova, OMD.....	234,612
California, University of Riverside, Calif.; PH 86-68-70.....	Conduct studies of effects of toxicity of photochemical atmospheres for experimental animals.....	F. G. Hueter, HER.....	128,228
California, University of Riverside, Calif.; PH 86-68-71.....	Conduct studies on the effects of air pollutants on plants and aerometry.....	W. W. Heck, EER.....	129,615
California, University of Riverside, Calif.; PH 86-68-72.....	Photochemical reactor studies.....	A. P. Alshuler, C. & P.....	37,159
Gallery Chemical Co., Pittsburgh, Pa.; PH 22-68-40.....	Sulfur recovery from flue gas via reversible dry absorbent.....	D. A. Kemnitz, PCE.....	47,889
Carnegie-Mellon University, Pittsburgh, Pa.; PH 22-68-38.....	Study of sulfur dioxide sorption by macroreticular ion exchange resins.....	J. P. Earhart, PCE.....	30,643
Chattanooga-Hamilton County Health Department, Chattanooga, Tenn.; CPA 22-69-41.....	Study of Chattanooga schoolchildren.....	M. E. Pearlman, HER.....	9,619
Children's Cancer Research Foundation, Inc., Boston, Mass.; PH 86-66-169.....	Carcinogenic studies on atmospheric pollutants.....	D. L. Coffin, HER.....	281,465
Cincinnati, University of Cincinnati, Ohio; PH 86-67-68.....	Eye irritation study.....	V. A. Newell, HER.....	21,821
Cincinnati, University of Cincinnati, Ohio; PH 22-68-28.....	Surveillance of air and population lead levels (cosponsored by NAPCA, API, and ILZRO).....	R. J. M. Horton, HER.....	69,414
Cincinnati, University of Cincinnati, Ohio; CPA 22-69-48.....	A comprehensive annotated lead bibliography.....	J. A. Brown, OTIP.....	74,826
Com-Share, Inc., Ann Arbor, Mich.; CPA 22-69-61.....	Automotive pollution index monitor/computing system (time-sharing computer services).....	E. J. Lund, MVPC.....	12,000
Copley International Corp., La Jolla, Calif.; CPA 22-69-50.....	Studies to assess the social and economic impact of odors—National survey of the odor problem.....	D. Gillette, EER.....	69,494
Drexel Institute of Technology, Philadelphia, Pa.; PH 22-68-10.....	Meteorological and air-quality measurements from TV tower.....	R. Goldberg, Abatement.....	33,900
Environmental Engineering, Inc., Gainesville, Fla.; and J. E. Sirrine Co., Greenville, S. C.; CPA 22-69-18.....	System analysis study of emissions control in the woodpulp industry.....	W. G. Tucker, PCE; F. L. Bunyard, EER.....	380,307
Environmental Resources, Inc., Riverside, Calif.; CPA 22-69-6.....	Development of realistic estimates of industrial costs of meeting air pollution abatement objective.....	O. Nichols, OTIP.....	118,118
Ernst & Ernst, Washington, D.C.; PH 86-68-37.....	Development of realistic estimates of industrial costs of meeting air pollution abatement objective.....	D. Walters, abatement.....	135,060
Ernst & Ernst (RFP Nos. 2, 5, and 8), Washington, D.C.; PH 22-68-29.....	Analytic studies in air pollution.....	R. Smith, OPD.....	242,775
Ernst & Ernst, Washington, D.C.; CPA 22-69-17.....	Cost effective air pollution control report.....	P. H. Gerhardt, OPD.....	9,955
Eso Research & Engineering Co., Linden, N.J.; PH 86-67-130.....	Fluidized bed contactor for reaction of SO ₂ in fuel gas with limestone-base material.....	J. S. Bowen, PCE.....	272,074
Eso Research & Engineering Co., Linden, N.J.; PH 22-68-55.....	Systems study of nitrogen oxides control methods for stationary sources.....	C. Giman, PCE.....	334,570
Eso Research & Engineering Co., Linden, N.J.; CPA 22-69-56.....	Study of gasoline composition and vehicle exhaust gas polynuclear aromatic content.....	T. W. Stanley, C. & P.....	32,879
Ethyl Corp., Ferndale, Mich.; CPA 22-69-12.....	Exhaust emission tests, 1966 car surveillance program.....	T. A. Huls, MVPC.....	69,190
W. L. Faith, San Marino, Calif.; CPA 22-69-54.....	National manpower study, private sector.....	H. Kramer, OMD.....	38,050
Florida, University of, College of Engineering, Gainesville, Fla.; CPA 22-69-34.....	Aerial survey for particulate contaminants and SO ₂ in the Parkersburg-Vienna, W. Va.-Marietta, Ohio area.....	H. H. Slater, abatement.....	4,420
FMC Corp., Princeton, N.J.; PH 22-68-57.....	Applicability of inorganic solids other than oxides to the development of new processes for removing SO ₂ from flue gases.....	L. Stankus, PCE.....	44,742
The Franklin Institute, Philadelphia, Pa.; PH 86-67-136.....	Screening, indexing, and abstracting of air pollution medical, engineering, and physical sciences literature with emphasis on extending foreign literature coverage.....	P. Halpin, OTIP.....	65,260
The Franklin Institute, Philadelphia, Pa.; CPA 22-69-30.....	Translation reactions.....	B. L. Evans, OTIP.....	26,512
GCA Corp., Bedford, Mass.; PH 86-67-125.....	Study of sulfur reactions in stack plumes.....	L. Niemeyer, Meteorology.....	80,320
GCA Corp., Bedford, Mass.; CPA 22-69-36.....	Study to determine the fate of CO in the atmosphere.....	J. J. Bufalini, C. & P.....	14,231

NAPCA ACTIVE CONTRACTS—Continued

Contractor and contract No.	Purpose	Project officer and division	Amount
GCA Corp., Bedford, Mass.; CPA 22-69-38	Fabric filter system study	D. Harmon, PCE	\$129,997
General Electric Co., Schenectady, N.Y.; PH 86-68-76	Removal of SO ₂ from flue gases by fractional permeation through immobilized liquid membranes	E. D. Margolin, PCE	103,283
General Technologies Corp., Reston, Va.; CPA 22-9-59	Infrared spectroscopic study of gas-solid interactions	R. Larkin, PCE	51,879
W. R. Grace & Co., Clarksville, Md.; PH 86-67-129	Development of improved alkaliized alumina	M. H. Hooper, PCE	705,707
Harbridge House, Inc., Boston, Mass.; CPA 22-69-58	Recommendation and implementation of multiproject management system for the planning and control of engineering R. & D. activities performed by non-Federal contractors	B. L. Beals, PCE	9,878
Harvard College, Cambridge, Mass.; PH 22-68-9	An epidemiological statistical study of a Boston air pollution episode	V. A. Newill, HER	7,298
Hertz Corp., New York, N.Y.; PH 22-69-5	Motor vehicle surveillance rental fleet study	W. Coll, abatement	11,924
Prof. W. W. Holland, St. Thomas Hospital Medical School, London, S.E., England; CPA 22-69-32	State-of-the-art review of chronic respiratory disease	C. M. Shy, HER	8,067
IIT Research Institute, Chicago, Ill.; PH 86-67-30	Conduct studies to determine the effects of exposure to atmospheric pollutants on the susceptibility of animals to respiratory diseases	D. L. Coffin, HER	277,309
Industrial Gas Cleaning Institute, Inc., Rye, N.Y.; CPA 22-69-5	Breakdown of air pollution control equipment sales	K. R. Woodcock, EER	15,000
Information Interscience, Inc., Philadelphia, Pa.; CPA 22-69-15	Screening, cataloging, abstracting, and indexing of literature pertaining to air pollution	P. Halpin, OTIP	8,249
Illinois, University of, Urbana, Ill.; PH 86-67-206	Sampling and evaluation of coal mines in Illinois by the Illinois Geological Survey	T. K. Jones, PCE	75,261
Institute of Gas Technology, Chicago, Ill.; PH 22-68-58	Studies on the availability and use of natural gas (LNG/NG) as a sulfur-free fuel for power generation	L. Stankus, PCE	54,425
Jefferson County Department of Health, Birmingham, Ala.; CPA 22-69-1	Birmingham soiling study	J. B. Upham, EER	11,328
The M. W. Kellogg Co., Piscataway, N.J.; PH 86-68-86	Evaluation of alkaliized alumina process	M. H. Hooper, PCE	265,360
A. M. Kinney Co., Cincinnati, Ohio; PH 86-68-92	Perform technical, economic, evaluation, and engineering services	D. R. Monti, PCE	123,203
Arthur D. Little, Inc., Cambridge, Mass.; PH 86-67-108	Study of low pollution potential vehicles-electric	R. C. Stahlman, MVRD	84,367
Arthur D. Little, Inc., Cambridge, Mass.; PH 86-67-288	Process cost and market study for pyrite-coal sulfuric acid process	T. K. Jones, PCE	67,207
Arthur D. Little, Inc., Cambridge, Mass.; PH 86-68-57	Study of high temperature regenerative amine absorption process (HITRAAP) for recovery of sulfur dioxide from boiler stack gases	E. D. Margolin, PCE	48,519
Arthur D. Little, Inc., Cambridge, Mass.; CPA 22-69-63	Investigations of diesel exhaust composition and odor	G. D. Kittredge, MVRD	33,263
Arthur D. Little, Inc., Cambridge, Mass.; CPA 22-69-23	Systems analysis study, reduction of air pollution from refuse incineration	R. C. Lorentz, PCE	255,281
Litton Systems, Inc., Camarillo, Calif.; PH 22-68-25	Analytic studies in air pollution	R. Smith, OPD	153,547
Louisiana State University, Baton Rouge, La.; PH 22-68-50	Rotoside sampling for aero-allergens associated with outbreaks of epidemic asthma in New Orleans	V. Hasselblad, HER	14,749
Loyola University, Hines, Ill.; PH 22-68-8	Survey sources of mortality and morbidity data within Chicago and establish relationships between intracity variations in mortality and levels of air pollution	C. M. Shy, HER	20,000
Maryland, University of, Baltimore, Md.; PH 22-68-5	Effects of environmental factors on human respiratory function	C. A. Cohen, HER	126,507
McNally-Pittsburg Manufacturing Corp., Pittsburg, Kans.; PH 22-68-59	Design and cost analysis study for a prototype coal cleaning plant	T. K. Jones, PCE	78,175
Massachusetts, University of, Amherst, Mass.; PH 22-68-39	Study of the chronic effects of low levels of air pollutants upon floricultural and vegetable plants in the Northeast	W. W. Heck, EER	30,755
Arthur G. McKee & Co., Cleveland, Ohio; PH 86-68-85	Systems analysis study of smelting industry	N. Plaks, PCE	386,667
Medical College of South Carolina, Charleston, S.C.; CPA 22-69-13	Relationship of cadmium to blood pressure among superphosphate plant workers and toxemia of pregnancy	C. M. Shy, HER	33,014
Meteorology Research, Inc., Altadena, Calif.; CPA 22-69-20	Particle study-turbulence study	C. R. Hosler, Meteorology	45,993

The Regents of the University of Michigan, University of, Ann Arbor, Mich.; CPA 22-69-51.	Kinetics of oxidation and quenching of combustibles in exhaust systems of gasoline engines.	G. Kittredge, MVRD	37,800
Mine Safety Appliance Research Corp., Evans City, Pa.; PH 22-68-11.	Applicability of inorganic liquids to the development of new processes for removing SO ₂ from flue gases.	E. D. Margolin, PCE	211,923
Monsanto Co., Monsanto Research Corp., Dayton, Ohio; CPA 22-69-8.	Feasibility study for the development of a multifunctional emission detector for CO, NO, and SO ₂ .	R. K. Stevens, C&P	58,127
Monsanto Research Corp., St. Louis, Mo.; PH 22-68-12.	Applicability of catalytic oxidation to the development of new processes for removing SO ₂ from flue gases.	G. L. Huffman, PCE	257,685
National Academy of Sciences, Washington, D.C.; CPA 22-69-31.	Advisory service on scale-up of air pollution control processes.	P. W. Spait, PCE	50,000
National Oil Fuel Institute, Inc., New York, N.Y.; CPA 22-69-53.	Residual and fuel oil data for standard metropolitan statistical areas.	J. C. Fensterstock, AQED	4,562
New York University, New York, N.Y.; PH 86-68-66.	Perform comparisons between British and American airborne particulate measurement methods.	F. Benson, HER	18,210
New York University Medical Center, New York, N.Y.; CPA 22-69-35.	Study of effects of ozone on cell membranes.	P. Levitt, HER	22,847
North American Rockwell Corp., Atomic International Division, Canoga Park, Calif.; PH 86-67-128.	Development of molten carbonate process for removal of sulfur dioxide from powerplant stack gases.	P. W. Spait, PCE	1,237,679
North Carolina, University of, Greensboro, N.C.; PH 22-68-2.	Conduct a comprehensive survey to identify and document known and suspected air pollution induced effects on various textiles and dyes.	J. B. Upham, EER	41,139
Northern Research & Engineering Corp., Cambridge, Mass.; PH 22-68-27.	Nature and control of exhaust emissions from aircraft engines.	G. Kittredge, MVRD	104,334
Ohio State University Research Foundation, Columbus, Ohio; CPA 22-69-46.	Development and presentation of course entitled "Contract Orientation for Project Officers."	C. Wilcox, OA	3,630
Oregon State University, Corvallis, Oreg.; PH 22-68-15.	Study economic impact of a fluoride-emitting source on the fruit tree industry in The Dalles area, Oregon.	W. W. Heck, EER	88,859
Owens-Corning Fiberglass Corp., Granville, Ohio; PH 22-68-64.	Evaluation of fabric filters to remove sulfur dioxide at elevated temperatures.	D. R. Monti, PCE	46,746
Peabody Coal Co., St. Louis, Mo.; PH 22-68-68.	Moving grate furnace study of limestone for control of sulfur oxides.	A. E. Potter, PCE	137,765
Pennsylvania State University, University Park, Pa.; CPA 22-69-37.	Air pollution research guide.	R. L. Kolbinsky, OTIP	20,563
Pittsburgh, University of, Pittsburgh, Pa.; PH 86-67-73.	Pathophysiological responses of humans and animals to single and multiple air pollution mixtures.	C. A. Cohen, HER	93,316
President and fellows of Harvard College, Cambridge, Mass.; CPA 22-69-45.	Laboratory technical services.	G. L. Huber, HER	9,372
Pressure Chemical Co., Pittsburgh, Pa.; CPA 22-69-21.	Procurement and preparation of airborne carcinogens.	D. L. Coffin, HER	19,955
Princeton Chemical Research, Inc., Princeton, N.J.; PH 86-68-48.	Development of processes to reduce sulfur dioxide to elemental sulfur by sulfide reduction.	G. Huffman, PCE	354,888
Research Triangle Institute, Research Triangle Park, N.C.; PH 22-68-30.	Chemiluminescent ozone measurement program—ozone-total oxidant relationship in ambient air.	E. C. Tabor, AQED	25,694
Research Triangle Institute, Research Triangle Park, N.C.; CPA 22-69-7.	Ozone chemiluminescent study.	A. E. O'Keefe, C. & P.	59,256
Research Triangle Institute, Research Triangle Park, N.C.; CPA 22-69-27.	A study of national emission standards for stationary sources.	R. Neligan, abatement	75,702
Research Triangle Institute, Research Triangle Park, N.C.; CPA 22-69-42.	An economic analysis of complying with national emission standards for stationary sources.	K. R. Woodcock, EER	35,070
Research Triangle Institute, Research Triangle Park, N.C.; CPA 22-69-57.	Studies related to air quality control regions, guides to good practice, control technology, and abatement field activities.	H. C. Miller, abatement	198,760
Roberts & Schaefer Co., Chicago, Ill.; PH 22-68-62.	Design and cost analysis study for a prototype coal-cleaning plant.	T. K. Jones, PCE	79,000
Scientific Research Instruments Corp., Baltimore, Md.; PH 86-68-65.	Conduct studies on sulfur control by means of coal gasification.	E. D. Margolin, PCE	241,884
Scientific Research Instruments Corp., Baltimore, Md.; CPA 22-69-40.	Improve instrumentation for determination of exhaust gas oxygenate content.	J. E. Sigsby, Jr., C. & P.	29,919
Scott Research Laboratories, Inc., Plumsteadville, Pa.; CPA 22-69-13.	Atmospheric reaction studies in the Los Angeles Basin.	A. P. Altshuller, C. & P.	189,178

See footnote at end of table, p. 123.

NAPCA ACTIVE CONTRACTS—Continued

Contractor and contract No.	Purpose	Project officer and division	Amount
Scott Research Laboratories, Inc., Plumsteadville, Pa.; CPA 22-69-47.	Effects of gasoline additives on carburetor and positive crankcase ventilation system performance as they relate to exhaust emissions.	C. Domke, MVPC.	\$34,025
Sign X Laboratories, Inc., Essex, Conn.; PH 86-68-94.	Obtain plume rise data from powerplants, Indiana, Pennsylvania.	C. R. Hosler, Meteorology.	25,346
Southern California, University of, Los Angeles, Calif.; PH 86-68-43.	Toxicity of controlled and ambiently polluted atmospheres study.	F. G. Hueter, HER.	462,766
Southern California, University of, Los Angeles, Calif.; PH 86-68-44.	Reactions of the human respiratory and circulatory systems to Los Angeles air pollutant studies.	C. M. Shy, HER.	184,189
Southwest Research Institute, San Antonio, Tex.; PH 86-67-72.	Investigation of diesel powered vehicle odor and smoke.	T. A. Huls, MVRD.	174,634
Southwest Research Institute, San Antonio, Tex.; PH 22-68-23.	do.	R. Statman, MVRD.	133,554
Southwest Research Institute, San Antonio, Tex.; PH 22-68-36.	A field study of diesel engine exhaust.	J. L. Raney, MVRD.	117,954
Sperry Rand Research Center, Sudbury, Mass.; PH 22-68-22.	Determine the capabilities of millimeter wave radiometers for remotely measuring temperature profiles pertinent to air pollution.	C. R. Hosler, Meteorology.	209,280
Stanford Research Institute, Menlo Park, Calif.; PH 86-85-27.	Conduct studies of the effects of low levels of nitrogen dioxide with regard to emphysema.	D.L. Coffin, HER.	299,751
Stanford Research Institute, Menlo Park, Calif.; PH 86-68-45.	Comprehensive planning study for the sulfur oxide control development program.	R.M. Jameson, OPD.	89,580
Stanford Research Institute, Menlo Park, Calif.; PH 86-68-73.	Study of application of electron microscopy to acid aerosol detection and size analysis.	J. Wagman, C. & P.	24,762
Stanford Research Institute, Menlo Park, Calif.; PH 22-68-33.	Lidar study of stack plumes.	C.R. Hosler, meteorology.	59,169
Stanford Research Institute, Menlo Park, Calif.; PH 22-68-35.	Inquiry into the economic effects of air pollution on electrical contacts.	J.B. Upham, EER.	32,965
Stanford Research Institute, Menlo Park, Calif.; CPA 22-69-43.	Study to determine the fate of CO in the atmosphere.	J.J. Bufalini, C. & P.	15,383
Stanford Research Institute, Menlo Park, Calif.; CPA 22-69-64.	Urban diffusion modeling.	C.R. Hosler, meteorology and C. & S.	40,000
System Development Corp., Santa Monica, Calif.; PH 22-68-56.	Conduct a survey of driving patterns in 5 cities relative to auto air pollution.	C.J. Domke, MVRD.	185,928
SystemMed Corp., Newport Beach, Calif.; PH 22-68-31.	Effect of carbon monoxide on performance of a tracking task.	W. Baldridge, HER.	54,395
Temple University, Philadelphia, Pa.; PH 22-68-52.	A study of economics of air pollution control.	P. Gerhardt, OPD.	34,712
Tracor, Inc., Austin, Tex.; PH 86-68-68.	Applicability of metal oxides to the development of new processes for removing sulfur dioxide from flue gases.	L. Stankus, PCE.	208,814

1969 NATIONAL AIR POLLUTION CONTROL ADMINISTRATION

Transfer of Funds to Other Federal Agencies¹

<i>Agency</i>	<i>[In thousands of dollars]</i>	<i>Amount</i>
Department of Agriculture-----		\$427
Atomic Energy Commission-----		324
Department of Commerce-----		1,424
Department of Defense-----		59
Federal Power Commission-----		35
Department of the Interior-----		1,642
Library of Congress-----		6
National Aeronautics and Space Administration-----		350
Tennessee Valley Authority-----		1,521
Total -----		5,789

¹ As of May 1, 1969.*Department of Agriculture*

Agricultural Research Service-----	\$217,000
Forest Service-----	210,000
Total -----	427,000

Agricultural Research Service

Projects.—Determine the effects of ozone and sulfur dioxide on field crops and ornamental plants, determine the physiological and pathological effects of air pollution on livestock and poultry, and development of air quality criteria for fluorides.

Forest Service

Projects.—Determine the air pollution effects on forest trees in the Eastern United States, determine the susceptibility levels of Western Conifers to various air pollutants, and development of efficient methods to assess the economic losses due to air pollution on vegetation.

Atomic Energy Commission

Argonne National Laboratory-----	\$200,000
Brookhaven National Laboratory-----	75,000
Oak Ridge National Laboratory-----	49,000
Total -----	324,000

Argonne National Laboratory

Projects.—Development and evaluation of an abatement program for Chicago using the statistical-analytical dispersion model technique and determine the status of high energy battery development.

Brookhaven National Laboratory

Project.—Development of a technique that will permit the tracing of sulfur compounds in the atmosphere.

Oak Ridge National Laboratory

Project.—Develops statistics which can be used to set up equations able to calculate plum rise and dispersion from tall stacks.

Department of Commerce

Business and Defense Services Administration-----	\$12,000
National Bureau of Standards-----	50,000,000
Environmental Science Service Administration-----	1,362,000
Total -----	1,424,000

Business and Defense Services Administration

Projects.—Determine the cost to the gray iron foundry industry of controlling air pollution and assess the economic impact of air pollution control expenditures in the secondary non-ferrous industry.

National Bureau of Standards

Projects.—Determine the effects of air pollution on the durability of building materials and determine the best location for air pollution recording devices.

Environmental Science Services Administration

Project.—Staff the National Air Pollution Control Administration's meteorology program.

Department of Defense

U.S. Army Tank—Automotive Command.....	\$57, 000
Office of Naval Research.....	2, 000
Total.....	59, 000

U.S. Army Tank—Automotive Command

Project.—Determine the possibility of low emission levels for diesel powered vehicles by changes in the engine operating levels.

Office of Naval Research

Project.—Support of the Toxicological Advisory Center of the National Academy of Sciences.

Federal Power Commission

Total	\$35, 000
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Projects.—Develop information on the present and future availability of clean fuels for selected urban areas and conduct a course in emission evaluation and control.

Department of the Interior

Bureau of Mines.....	\$1, 580, 000
Office of Coal Research.....	62, 000
Total	1, 642, 000

Bureau of Mines

Projects.—Determine the influence of fuel composition, engine operating variables and emission control techniques in altering motor vehicle emissions; determine the amounts and identities of objectionable materials in diesel fuels and establish operating variables in terms of emissions; development of alkalized alumina processes for the removal of sulfur oxides; development of methods to remove pyrite sulfur from coal; and determine the availability of Appalachian low sulfur coals.

Office of Coal Research

Project.—Determine the characteristics of emissions and ways of controlling them from coal-fired fluoridized bed combustion systems.

Library of Congress

Total	\$6, 000
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Project.—Copies of air pollution bibliography.

National Aeronautics and Space Administration

Total	\$350, 000
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Projects.—Develop thermal reactors for control of hydrocarbon and carbon monoxide emissions from motor vehicles and membership contribution to the International Advanced Power Group.

Tennessee Valley Authority

Total	\$1, 521, 000
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Projects.—Full-scale field study of inversion breakups at large power plants, development of limestone injection processes for controlling emissions of sulfur oxides from power plants burning high sulfur fuels, development of a pilot plant study of controlling power plant stack gases by ammonia scrubbing, economic evaluation of processes for reducing sulfur oxides from power generating plants, study of effects of air pollution from tall stacks on vegetation.

